ILLUMINATING ENGINEERING

AUGUST 1953

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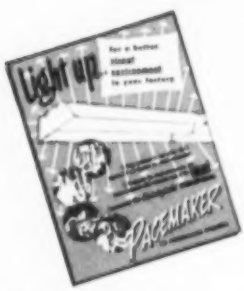
Recommended Practice for Residence Lighting
Usage for Words "Helios" and "Luminance"
Tungsten in the Lighting Industry
Lighting for Compact Shelving
Swimming Pool Lighting
High-Bay Industrial

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

Here's an industrial luminaire that has nearly everything



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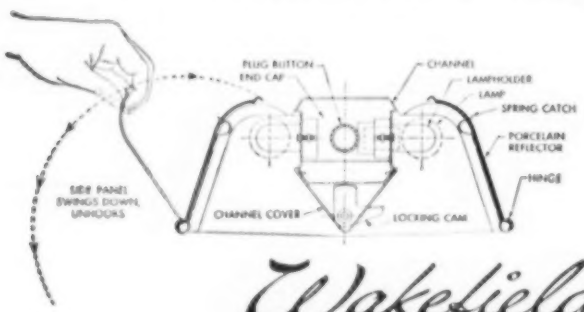

Now do you see why we say the Pacemaker has nearly ev,rything? To be honest, we think it does have everything a modern industrial luminaire ought to have, but a little understatement never hurts. At that, there is one thing it doesn't have. It doesn't have a sky-high price tag.

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...the only ballast of its kind

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Why take this chance when *you can be sure of safety* by using the new, Westinghouse *lead-lag* ballast now available at new low prices and small sizes? Consider these other advantages and you'll never be satisfied with anything less than Westinghouse *lead-lag:*

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2. Independent lamp operation. Accurate check on lamp burnouts. No premature replacement. Lose light output only from lamp actually burned out.
3. Low installation costs, because of simple wiring, light weight and small sizes in the *new* Westinghouse *lead-lag* ballast.
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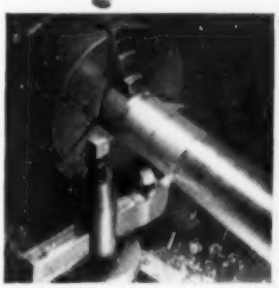

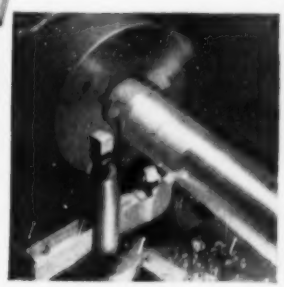

In left-hand photo, the lathe is purposely stopped to demonstrate the dangerous illusion that can result under conditions where series ballasts are in use. *In right-hand photo,* the lathe is in operation, an apparent fact when the light source incorporates a *lead-lag* ballast.

YOU CAN BE SURE...IF IT'S

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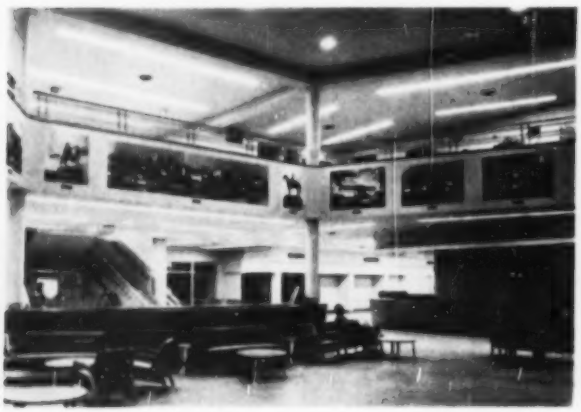

There's a LITECONTROL Fixture for every scene and situation. You, too, can have "custom" beauty and performance at "standard" prices. Write for catalog and complete information.

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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No. 8

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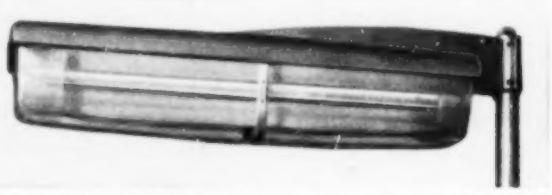

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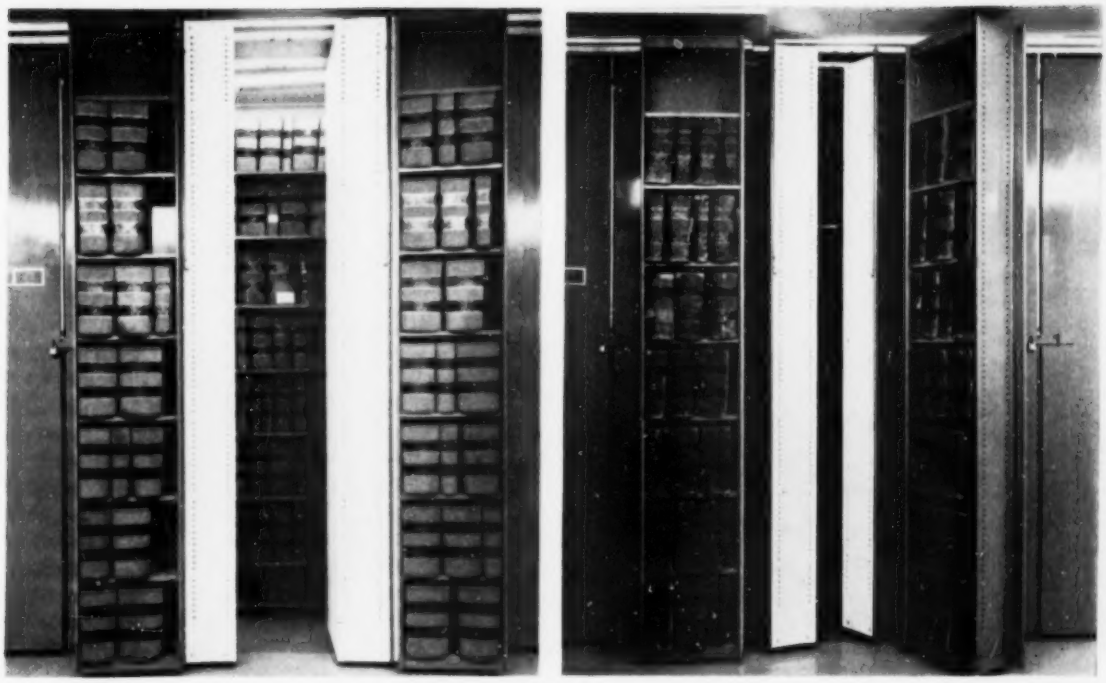


Compact shelving unit wide open and illuminated with the interior, corridor, and angle lights is shown in photo at left. At right is the intermediate stage of opening the compact shelving units. All photographs were taken with only local light, using no auxiliary illumination.

Compact Shelving . . . A Lighting Problem

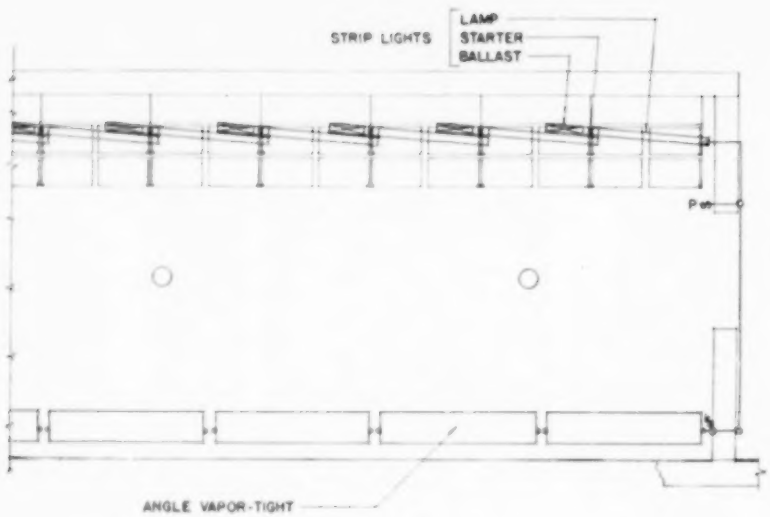
By FRANK BABIAK, JR.
J. WALTER MARQUARDT

LIGHTING principles would apply, ideally, to every area requiring good visibility. The physical limitations of some jobs, however, offer a real challenge in the application of those principles. Lighting the compact shelving in the basement corridor of the Archives Building of the Illinois State Library in Springfield, Illinois, was just such a problem. It was the first and only lighting installation of compact shelving of three sections as far as we could learn, so that previous experience was not available in its solution.

Compact shelving is a relatively new device, consisting of three units of shelving which may be folded together, with the top unit turned inward making a solid exterior, which may be locked. The device is especially adaptable to the filing and storage of books or records infrequently used, and can be located in spaces not normally suitable for ordinary book shelves. The assembly consists of (a) standard shelving three feet wide against the wall; (b) a second unit divided into two parts, each of which may be "unfolded" for access to the back shelving; (c) an outside unit also in two parts, but facing inward, providing a door of solid metal on the outside. Because of the folding shelves, the narrow access space and the very limited space above the shelving, lighting at the Illinois State Library was very poor and book titles almost impossible to see.

Our first step was to paint all interior surfaces a flat white to make maximum use of the light available. Because of the catches on the intermediate section into a rib of the ceiling of the units, inadequate space was available to install any light ahead of the center of the intermediate shelves.

AUTHORS: Babiak Electric Service (Contractor) and Illumination Consultant, respectively, Springfield, Illinois. This installation took third prize in the contest for "My Most Interesting Lighting Job" conducted by the St. Louis Section of I.E.S.



Plan view showing overlapping of starter and ballast for one lamp into the adjacent section. Angle lights are shown, installed on opposite side of corridor.

TABLE I.—Maintained Illumination Levels (in footcandles).

	Top	Middle		Bottom
Shelving wide open				
Innermost shelves*				
Vertical	150	27	18	17
Horizontal	40	28	15	19
Rear corner of rear shelf				
Vertical	—	25	16	—
Horizontal	—	10	5	—
Shelving partly open				
Innermost shelves	Top	Middle		Bottom
Vertical	8	15	18	19
Horizontal	32	35	28	20
Outermost shelves				
Vertical	5	18	25	23
Horizontal	32	48	35	20

*With shelving in wide open position innermost shelves receive light from corridor lights and angle lights in addition to strip lights.

Angle units are mounted on the opposite wall of the corridor, to direct light to the intermediate and outside divisions of the compact shelves.

Since the shelves are standard three-foot units, it was decided (for clearance) to make use of a recessed strip light, surface-mounted, installing it in such a manner that the fluorescent tube extended over the shelving section with the starter and ballast extending into the adjacent sections, using only sufficient slant that the ballast would overlap the lighting unit in the next section. (See drawing.)

As this lighting was only useful for the back shelving, angle lights were installed in the opposite side of the corridor and directed to the center of the unit in order to obtain additional light both by direct illumination and by reflection from the sides and floor of the compact shelving. The installation is in an infrequently used corridor and in order to discourage pilfering of fluorescent tubes, an enclosed fixture was used for the corridor angle lights. The units were mounted with chains and a turnbuckle on one side to maintain full control of the angle of tilt.

Positioning is approximately six inches below the ceiling and six inches from the wall. In this installation the capillary tube for the building fire alarm system runs along the moulding behind the fixtures and the spacing was considered necessary so as not to set off the fire alarm system.

Horizontal and vertical footcandle readings are given in Table I. These readings were taken after nine months' operation.

Acknowledgment is made for assistance on this installation to Helene H. Rogers, Assistant State Librarian, Illinois State Library; P. M. Erwin, Curtis Lighting Inc., St. Louis; T. F. Jordan, Benjamin Electric Mfg. Co., Chicago; Art Metal Company, Jamestown, N. Y., their engineer, Mr. Beaumont and their local representative, Mr. M. A. Barker.

A.I.A. File No. 31

INSTALLATION AT JUSTER BROTHERS, 43 SOUTH SIXTH STREET, MINNEAPOLIS, MINN.

Lighting a Men's Clothing Store

LIGHTING OBJECTIVE: To provide suitable illumination for the appraisal of men's wear.

GENERAL INFORMATION: The 54 x 49-foot main sales floor shown above is immediately inside the front doors. Ceiling height is 13 feet 2 inches. All types of men's wear are displayed — from multi-colored ties and jewelry to leather goods. The side walls and ceiling are gray (75% RF), floor is mottled brown tile (44% RF), woodwork (33% RF) and showcase trim (50%) are brown.

INSTALLATION: General illumination is provided by a combination of six-lamp recessed louvered fluorescent units (Garey No. 7895 with 40-watt warm white lamps) and 150-watt PAR floodlight units (Garey "Drumalier" No. 6809). A continuous valance (Garey "Addastrip" No. 8000-48) over the wallcase illuminates the shelves and brightens the rear walls. The showcases are illuminated by continuous Garey No. 9921 units with warm white lamps. Garey No. 5500 louvered recessed troffers containing two 40-watt fluorescent lamps are installed near the elevators.

(over)

A.I.A. File No. 31

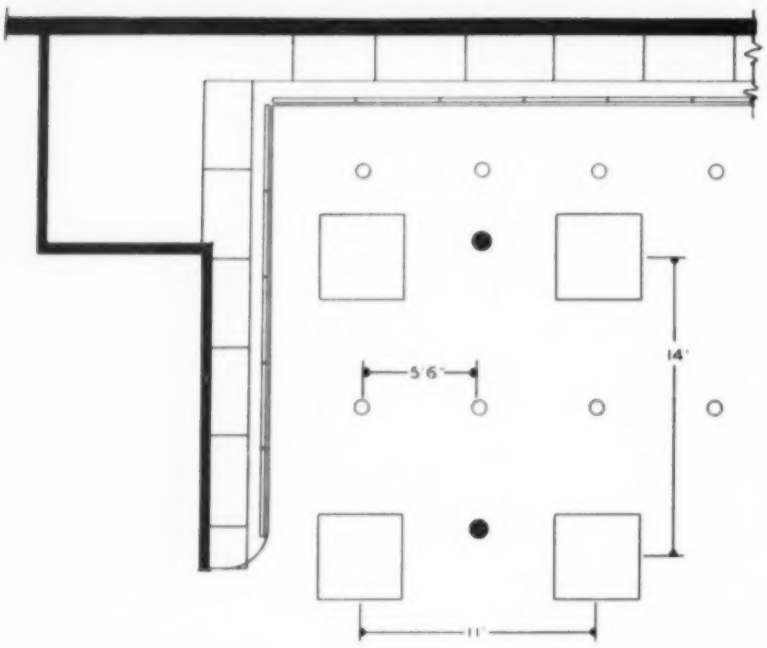


Figure 2. Partial plan view showing luminaire spacing.

Illumination after 4000 burning hours (17 months after installation) was as follows:

Average general lighting (30 inches above floor)	40 ft-c
Showcase	
top shelf	80-90 ft-c
second shelf	80-100 ft-c
bottom shelf	75-85 ft-c
Counter tops	30-95 ft-c

Brightness distribution is indicated below:

Ceiling	3.5 ft-L
Upper walls	7.0 ft-L
Wall just above cove	20 ft-L
Lower walls	19 ft-L
Columns	2.3 ft-L
Wall cases	2.8 ft-L
Counter top	5 ft-L
Counter sides	1.1 ft-L
Floor	10 ft-L
Luminaire louvers (45 degrees)	120 ft-L

Lighting designed by Larson and McLaren, Architects, and installed by Industrial Electric Company of Minneapolis.

Lighting data submitted by J. B. McCracken, Northern States Power Company, Minneapolis, as an illustration of good lighting practice and to aid in the design of similar installations.

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Series XVIII 8-53

Tungsten In The Lamp Industry

By GEORGE MORITZ

TUNGSTEN is a metallurgical tough guy. It's the hardest metal known, has the highest melting point of any metal (about 3400 degrees C), and has tensile strengths of 600,000 pounds per sq in at small diameters. Although it is found in varying amounts in many parts of the world, tungsten has never been found in the free state, the main ores being wolframite ($FeMnWO_3$) and Scheelite ($CaWO_4$). It's not easy to get pure tungsten and, once obtained, not too easy to keep.

Despite its somewhat miraculous properties, tungsten cannot be classified as a modern wonder metal since it has been known for 170 years and has been in use nearly as long. Its first industrial use was as an alloying agent in steels to make them wear-resistant. That continues to be a major use today. Pure tungsten is used in relatively few industrial applications, lamp and electronic tube filaments and contacts in make-and-break circuit devices being the principal ones. The lamp industry uses only a few hundred tons of tungsten per year but the metal itself has often been called the heart of the lamp industry, and understandably so. Wire for use as a lamp filament has a tough job. Tungsten is the only metal known today that can do the job to the standard required. Even at that it takes some careful manipulating.

Production of Tungsten Wire

Wire Requirements

Filaments consist of minute and accurately wound wire. Often an initial coil is made and that in turn is wound into a second coil. Sometimes, it's even carried a step further and the second coil (coiled-coil) is wound into a third. Obviously, filament wire must be malleable and ductile. Yet, the filament cannot sag from its fabricated shape without lessening its efficiency. Hence it must be strong and non-sagging. In addition, the wire must have a high melting point, must be fairly vibration resistant, must have a high resistivity, and a low vapor pressure.

AUTHOR: Metallurgical and Chemical Dept., Lamp Division, Westinghouse Electric Corp., Bloomfield, N. J.

Haply, tungsten has many properties which automatically fit the requirements. It has a high melting point; its resistivity is, of course, almost directly proportional to temperature; its tensile strength increases as the diameter decreases; it has a general resistance to the effects of high temperature; and it possesses a low vapor pressure at elevated temperatures. Other characteristics of tungsten have been engineered to meet the demands of filament wire.

The chemical processes involved in the production of tungsten for filament wire are largely concerned with obtaining pure tungsten powder. Filament wire with the desired crystal structure to resist sag and yet be ductile is formed from this powder by powder metallurgy and treating methods.

Purification

The purification of tungsten ore in unique in that it is not done in the usual manner of melting the ore and removing the impurities as a slag. Because of its high melting temperature it cannot practically be melted in crucibles. Carbon crucibles would withstand the temperature but would contaminate the tungsten. It therefore becomes necessary to use a combination of a chemical purification followed by furnace reduction to metal

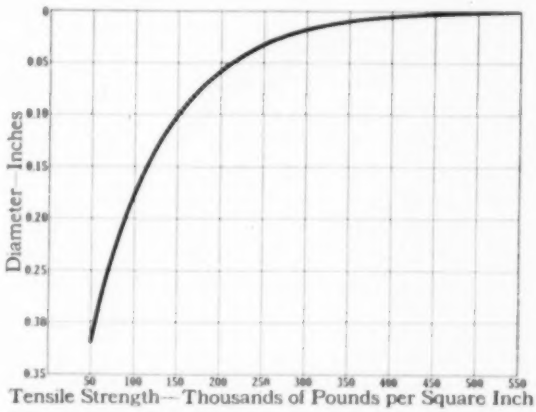
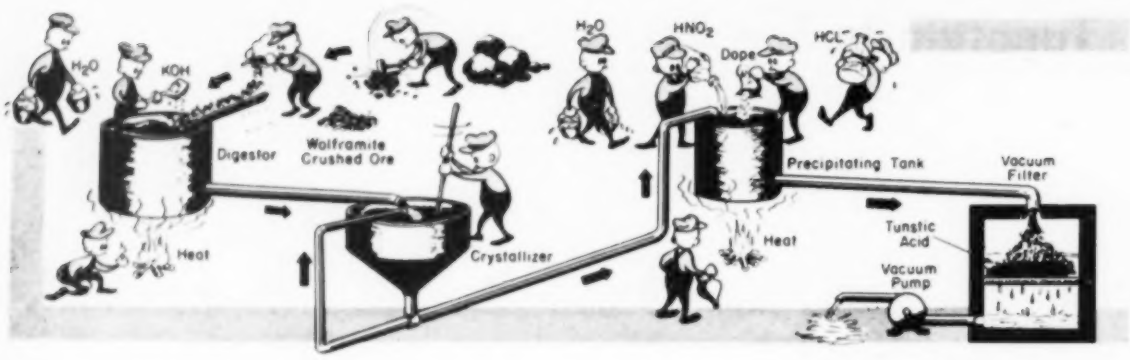


Figure 1. Tensile strength of tungsten increases as the diameter of the wire decreases.



powder. This procedure is quite meticulously carried out since small quantities of impurities such as tantalum, columbium, arsenic or phosphorus have a very decided effect on its properties and make working of the metal into wire an impossibility.

Manufacture of the wire consists roughly of the following successive operations: (1) Purification to tungstic oxide (WO_3); (2) reduction of tungstic oxide to pure metal powder (99.6 per cent); (3) pressing of metal powder into ingots; (4) treating or sintering the ingots in a hydrogen atmosphere by means of electrical current; (5) swaging the square ingots to partial round bar; (6) drawing into wire; (7) annealing at various stages to relieve work strains; and (8) cleaning the wire in a hydrogen atmosphere with heat.

The tungsten ore in the form of coarse brown particles is first chemically analyzed to check the WO_3 content of the ore and to test for the many impurities that may be present. Having fulfilled the specification analysis requirements, the ore is ready for purification.

Digestion

The first stage in the manufacture of metallic tungsten is the separation of the WO_3 from the gangue materials. Extraction with caustic alkali is a major method and the one used in the Lamp Division. The ore is pulverized so that all of it passes a 100 mesh screen. Calculated amounts of water, ore, and potassium hydroxide are added to a large steel tank or digester supplied with an agitator and heated by gas. The process of getting the tungsten in solution by heating and agitating requires several hours. Water is added from time to time to prevent the resulting potassium tungstate solution from crystallizing upon cooling. After complete dissolution has taken place, this solution is decanted. Most of the impurities settle to the bottom of the tank as a sludge while the top liquid contains the tungsten in solution as potassium tungstate. Small amounts of iron, molybdenum, calcium, aluminum, and silicon may also be in solution with the tungsten.

Crystallization

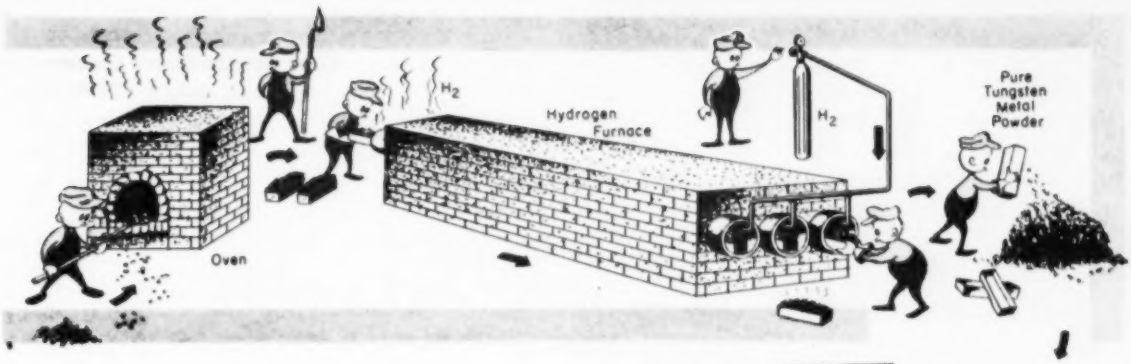
The clear potassium tungstate solution is then filtered and crystallized in another steel tank where the solution is heated and agitated. Crystals of potassium tungstate form at a specific concentration and settle to the bottom of the tank. Several such crystallizations are usually necessary before the desired pure white crystals of potassium tungstate are obtained. The crystals are separated from the liquid (mother liquor) by filtering, dissolving in water, and pumping into a rubber lined tank for the next step — precipitation to tungstic acid (H_2WO_4).

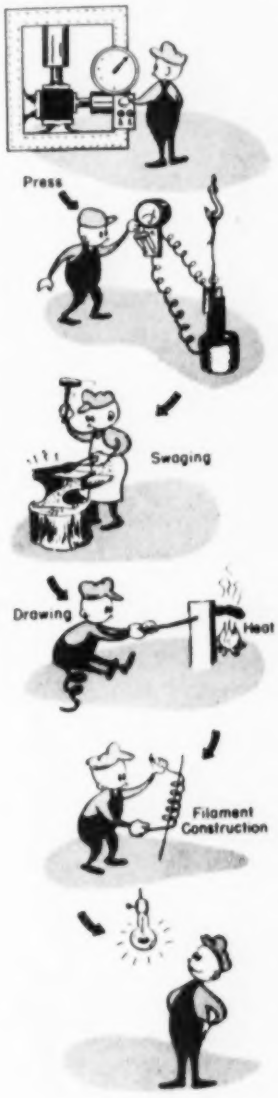
Precipitation

Precipitation comes about when the hot potassium tungstate solution is added to hot hydrochloric acid and water in the precipitating tank. A steam jet is used to heat the liquid to about 80 degrees C. Constant agitation assures a more complete precipitation of the H_2WO_4.

The precipitated tungstic acid is very temperamental. It may be affected by temperature of solution, order of addition of acids, concentration, time of precipitation, and the rate at which the potassium tungstate is added to the acid. These variables are, of course, kept constant.

At the end of precipitation, nitric acid is added to prevent the solution from going colloidal. The canary-yellow precipitate of tungstic acid is decanted and given six water washes. After the washing, intentional additions of foreign material are made. These additives or so called "dopes" con-





sist of small percentages of either potassium chloride (KCl) and potassium silicate (K_2SiO_3) to produce a non-sag tungsten filament or the addition of a thorium nitrate $Th(NO_3)_4$ to produce a vibration-resistant filament. The doped tungstic acid is subsequently dried in preparation for the reduction to metal powder. Such drying, of course, results in dehydration of the acid to tungstic acid.

The oxide is reduced to the metal powder by passing hydrogen gas over it. This is done in a hydrogen furnace in a continuous flow. The oxide is loaded into iron, nickel, or molybdenum boats, which hold several hundred grams, and passed through long metal tubes. Hydrogen is made to pass through these tubes and they are heated either electrically or by gas.

A two-stage reduction is generally used in order to obtain a more uniform product. The furnace has three zones. At the first reduction, the temperatures range from 600-750 degrees C producing a mixture of partially reduced metal powder and completely reduced powder. The second reduction takes place at a gradient of 650-850 degrees C. The fineness of the resultant metal powder is dependent on temperature of reduction, stoking time, hydrogen flow, and depth of oxide in each boat. The particle size of the tungsten powder for use as filament material may range from .10 to 8 or 10 microns.

Pressing

Once the powder has been obtained, powder metallurgy methods are used to get a tungsten ingot. Interestingly enough, tungsten was one of the first metals to use powder metallurgy as an adjunct to its purification processes.

The metal powder, obtained from the final reduction process is thoroughly blended, sieved, and hydraulically pressed into a rectangular ingot. This ingot is made by pressing the powder in a

steel mold under 15-20 tons pressure. The resulting ingof is fragile and lacks any definite crystal structure. Pre-heating the ingot in a hydrogen furnace at a temperature of 1000-1100 degrees C for an hour supplies sufficient strength to permit subsequent handling. The apparent density of a pressed ingot ranges between 10 and 12.

Treating or Sintering

The next step is, of course, to produce the desired crystal structure in the ingot. The first advance toward this structure is the sintering or treating operation which consists of passing a high current through the pressed ingot while it is suspended in a hydrogen atmosphere. The ingot is suspended between a fixed contact and a mercury pool in a hydrogen filled, water-cooled metal envelope. The current used is between 2500-3000 amperes. The current is thus treated to within 10 per cent of its fusion current and consequently becomes a crystalline metallic bar of virtually pure tungsten. At this high temperature, most of the remaining impurities are eliminated. A shrinkage of the ingot of about 10-15 per cent takes place during this treating operation and the density is increased to about 18.

Swaging

The ingot is strong but brittle at room temperatures and must be heated to about 1600 degrees C in an electric furnace in a hydrogen atmosphere before it can be worked (swaged). Swaging essentially consists of inserting the heated ingot between rapidly rotating hardened steel hammers. These hammers, which deliver 10,000 blows per minute, round and elongate the ingot. Continued swaging to smaller diameters gives rise to the development of a large fibrous structure which in turn imparts ductility and toughness to the rod. Each time the rods are swaged they are heated prior to swaging. The rods are subjected to decreasing sizes of swaging hammers until they are reduced to .090 inch in diameter.

The drawing operations consist of lubricating the wire with colloidal graphite, applying heat, and pulling through composition and diamond dies. As the diameter of the wire is decreased, the drawing speed is increased and the temperatures are decreased. It is necessary to interject annealing steps during these swaging and drawing operations, thus relieving the terrific strains set up in working the tungsten rod to fine wire. These annealing steps along with the working operations change the fibrous structure to a crystallized grain structure.

Tungsten wire can be drawn to a diameter of .000394 inch and must be held to within a diameter tolerance of ± one per cent or about 4/100,000 of an inch. These small dimensions are not measured with a micrometer but are determined by weighing a 200 mm length of wire.

History and Abundance

The famous Swedish chemist K. W. Scheele (after whom the tungsten bearing ore Scheelite is named) appears to have given tungsten its name from the Swedish "tung" meaning heavy and "sten" meaning stone. The element itself, however, was first identified as such by the brothers de Elhuyar in 1783. Shortly thereafter scientists began searching out industrial applications for the newcomer and almost immediately came up with the idea of using it as an alloy to harden steel. By 1850, plans were underway for separation of tungsten from its ore on an industrial scale. It was not until 1904 that Just and Hannaman invented a process for drawing tungsten wire. Five years later, Coolidge patented a process for briquetting tungsten powder, sintering the ingot in protective atmospheres, and subsequently working it at high temperatures to produce a ductile metal.

Fairly rare and very strategic, tungsten is considered to be the thirtieth element in order of abundance as found in nature. Although it has many ores, those most commonly used by the lamp industry are Wolframite ($FeMnWO_3$) and Scheelite ($CaWO_4$). The largest deposits of tungsten bearing ores occur in Asia in China, Burma, Malaya, and Japan. South America has large deposits in Argentina and others in Bolivia and Brazil. Other deposits around the world occur in Australia, Portugal, Spain, Sweden, Germany, Russia, South Africa, Canada, and the United States. United States' deposits are found mainly in the rocky mountain states of Nevada, Utah, Idaho, Arizona, California, and Colorado.

A set of standard specifications giving minimum percentages of WO_3 content and maximum impurity percentages in various ores were set up by the War Production Board, in 1944. Tungsten purchasers now use these specifications in buying.

The ore is now purchased on the basis of its WO_3 content; it is purchased in twenty-pound or so-called short-ton units. The price of tungsten has fluctuated greatly in the past decade, so much so, in fact, that some tungsten users have set their research departments to work on finding a suitable substitute. With its remarkable record in the lamp industry, tungsten would indeed be at least extremely difficult to replace.

TUNGSTEN — from oxide to filament

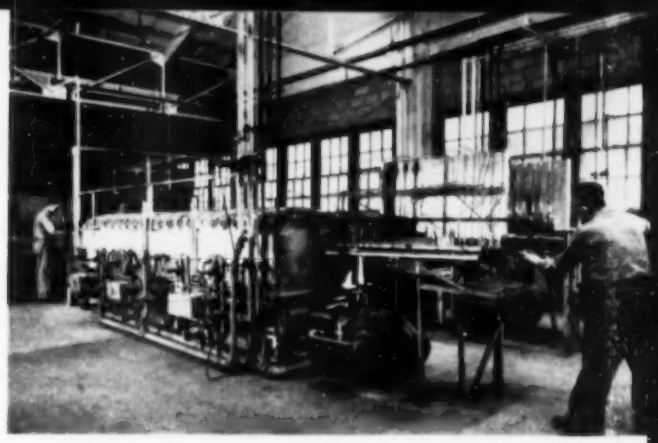


Figure 2. (right) This gas-fired hydrogen furnace is used in the reduction of tunstic oxide to tungsten. The oxide is loaded in boats and pushed through the heated tubes. Hydrogen gas is passed through the tubes in the direction opposite to the flow of the boats.

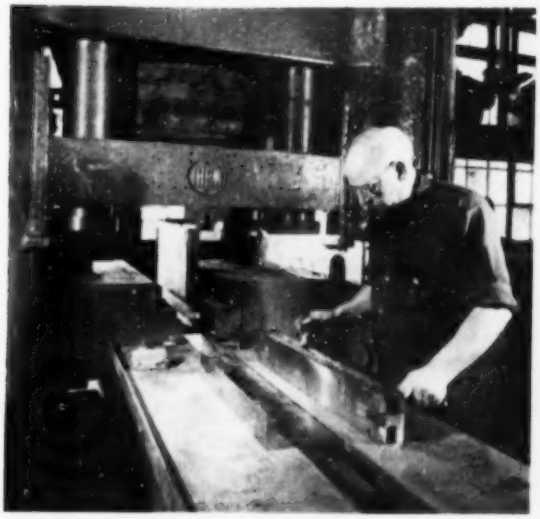


Figure 3. The tungsten powder is pressed into an ingot. This worker is leveling the powder in a mold prior to the pressing operation.

Figure 4. The pressed ingot is sintered by passing a high current through it. Here it is being inserted between the copper electrode at the top and a mercury pool. The mercury pool prevents breakage by allowing the ingot to move while it is shrinking.

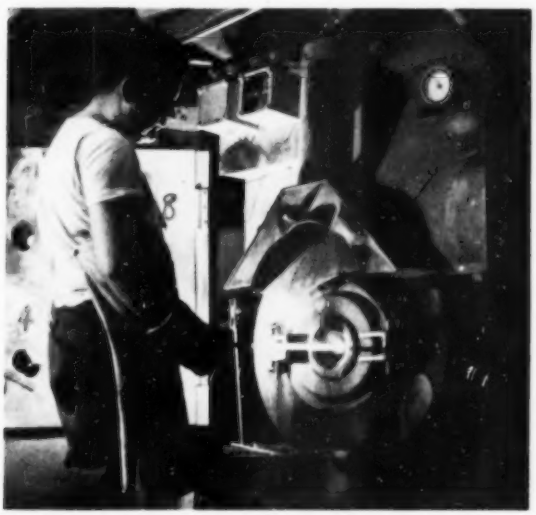


Figure 5. The first step in making wire from the ingot is hand swaging. Mechanical swaging follows.

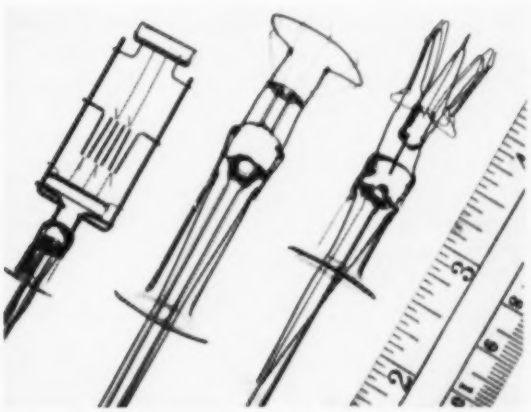


Figure 6. A group of completed filaments mounted on glass bases. All are of the single-helix type.

Tungsten—Its Application In Electric Lamps

By W. E. ANDERSON

ABOUT 1.5 per cent of the tungsten consumed in this country yearly is used in electric lamps. The bulk of this is used as filament material in incandescent lamps, the remaining as supports for the filament, as seal wire for lead-in conductors in hard glass lamps, and as heater elements for electrodes in gas- or vapor-discharge lamps. In these applications, the greatest use is in the form of round wire, ranging in diameter from about three ten-thousandths of an inch to approximately fifty-thousandths of an inch. A comparatively insignificant amount is used in the form of flat ribbon.

Drawn Tungsten Wire to Coiled Filament

In making a coiled filament from tungsten wire there are four main steps: (1) the coil-winding operation on a mandrel; (2) baking or coil setting; (3) cutting coils to length; and (4) dissolving the mandrel.

The most common method of forming coils or helices is to continuously wind the tungsten wire on either iron or molybdenum mandrel wire. Coils for the general-lighting-service lamp are usually wound continuously, while for other lamps the coils are wound in sections. Some filament coils are wound with as many as 2100 turns per inch, which means that the spacing between coils is slightly less than one two-thousandth inch and none of the turns must touch or even vary perceptibly in spacing.

The wound coils are then baked on the mandrel in a hydrogen-atmosphere electric furnace to relieve strains set up during the coiling and thus give a permanent set to the coil so that on removal of the mandrel the coil will remain as wound. Continuously wound coils must be cut to the required lengths before dissolving the mandrel wire.

The mandrel wire is removed from the coil by dissolving in acids that do not attack the tungsten coil. The coils are thoroughly washed in water to remove this acid and are finally washed in alcohol and dried.

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The coils, after a thorough inspection for lengths, uneven winding and surface defects, are ready to be mounted in lamps. The tungsten coil is "flashed" during the lamp assembly operation, which is performed on a lamp machine. Flashing consists of a step increase in voltage through the filament until the operating voltage of the lamp is reached. This treatment develops a crystal structure in the filament that is instrumental in preventing sagging of the filament.

Practically all lamps require tungsten for one or another function. In incandescent lamps, tungsten in the form of either single-helix or double-helix (coiled-coil) coils consitutes the light-emitting filament. In other types of lighting, such as fluorescent or mercury-vapor lighting, tungsten is an electron-emitting element for exciting light from gas or vapor. The single helix is made by winding the wire on a mandrel with a spacing between turns of from two to eight tenths of the diameter of the wire; and on a mandrel ranging in diameter from $1\frac{1}{2}$ to 5 times the diameter of the filament wire. This primary coiled mandrel is then wound on a second mandrel; then the mandrels are removed either by mechanical or chemical means.

The fundamental object in coiling filaments is to take advantage of the interchange of radiant energy between adjacent turns of the wire and to reduce the surface cooling (particularly as regards gas-filled lamps). This obtains the maximum efficiency in light production in terms of lumens per watt, for the length of time the lamp is expected to burn. The life in hours of a tungsten filament is approximately inversely proportional to the seventh power of the efficiency.

The first tungsten filament lamps were of the vacuum type with the straight (not coiled) wire draped over the supporting structure in squirrel-cage fashion. A vacuum was necessary to prevent rapid oxidation and consumption of the filament when it was raised to incandescent temperatures. On the other hand, at reduced pressure, the tungsten evaporated at an increasingly rapid rate as the temperature was raised, and condensed on the inner surface of the glass bulb. This not only caused the light output from the filament, when

burned at a constant voltage, to diminish rapidly with time, but also increased the absorption of the light as the deposited film of condensed tungsten on the bulb became more dense. Although ways and means were devised to diminish the effect of light absorption, it was not until the principle of applying a counter pressure on the filament — thus repressing the evaporation at the source — was devised, that this so-called lumen maintenance was substantially improved. This was accomplished by filling the lamp with a gas such as nitrogen (and later argon) that was inert to the hot tungsten. But the gas also had a cooling effect; it was found that coiling the filament greatly improved the initial efficiency of the lamp for a given life and the lumen output throughout its life remained more nearly constant.

Fortunately, the necessity for coiling the filaments did not appear until after drawn tungsten wire, with its greatly improved ductility, was developed. This took care of the mechanics of forming the coil and getting it mounted within the lamp. After it started to burn, however, the turns gradually opened up and the coil sagged as the result of gravitational pull. If this could be prevented, even greater improvement could be had in efficiency as well as lumen maintenance. Research as to the cause of this tendency to sag disclosed that the thorium oxide, product of thorium nitrate added as an original ingredient to prevent off-sets in the filament, in turn tended to promote sag when the filament was coiled and raised to operating temperature. The thorium oxide retarded crystal growth after the tungsten recrystallized out of its drawn fibrous structure and increased the vibrational strength when brought up to the operating temperature of the filament. A change in this "dope" (*i.e.*, using potassium chloride and potassium silicate instead of thorium nitrate) not only promoted crystal growth but also influenced the shape in such a way that the crystals became interlocking and supported each other against dislocation by gravity when hot. Not only did this solve the sag problem but also improved the ductility of the cold wire to the point where it could be wound into coils without auxiliary heat applied to the point of winding on the mandrel.

To give some idea of the effect of coiling the filament on lamp efficiency, as a result of interchange of radiant energy between turns in vacuum, Table I is of interest. This shows the effect, in terms of per cent of the efficiency of an uncoiled filament, of various mandrel and pitch ratios for filaments operated at the same current.

The same table shows the approximate effect produced in a gas-filled lamp by two commonly used gases; also the percentage effect of double coiling is indicated. All filaments are of the same diameter, operated at the same current.

TABLE I.—Effect of Filament Coiling on Lamp Efficiency.

Filament	Gas	Per Cent Mandrel[1]	Per Cent Pitch[2]	Per Cent Efficiency
Not coiled	Vacuum			100
Single helix	Vacuum	500	180	112
Single helix	Vacuum	500	150	127
Single helix	Vacuum	200	150	156
Single helix	Vacuum	200	120	195
Not coiled	Nitrogen			40
Single helix	Nitrogen	200	150	50
Single helix	Argon	200	150	70
Single helix	Argon	500	150	90
Coiled coil	Argon	200/200	150/150	135

[1] Per cent mandrel is the ratio of the diameter of the mandrel to that of the filament times 100, *i.e.*,

$$\frac{d_m}{d_f} \times 100 = \text{per cent mandrel}$$

[2] Per cent pitch is the ratio of the pitch of the wound coil (distance between turns) to the diameter of the filament times 100, *i.e.*,

$$\frac{P}{d_f} \times 100 = \text{per cent pitch}$$

TABLE II.—Properties of Tungsten.

Melting point	3410 ± 20 deg C
Rate of vaporization at 2500 deg K	9.18×10^{-10} grams/cm²/sec
Rate of vaporization at 3000 deg K	9.92×10^{-7} grams/cm²/sec
Resistivity at 28 deg C	5.64 microhms/cm³
Resistivity at 2500 deg K	77.25 microhms/cm³
Resistivity at 3000 deg K	96.2 microhms/cm³
Normal brightness at 2500 deg K	237.5 candles/cm²
Normal brightness at 3000 deg K	1257 candles/cm²
Color temperature at 2500 deg K	2557 deg K
Color temperature at 3000 deg K	3094 deg K

In studying these relationships it must be remembered that the wire diameter and input current are constant, and that any increase in interchange of radiant energy, or loss due to the cooling effect, increases or decreases the temperature of the filament. Since the burning life of the filament is inversely proportional to the maximum temperature of any one spot along its length, the life of the lamps at these efficiencies varies accordingly. To absorb the increase in energy due to coiling and have the filament remain at the same temperature, a decrease in current density, or, conversely, an increase in the filament wire diameter is necessary. Similarly, an increase in current density or decrease in filament wire diameter is necessary to compensate for the cooling effect of a gas.

Coiled filaments must also be arranged in different forms within the lamp depending on the service for which the lamp is designed. For example, in general-lighting lamps the primary requisite is that the filament, mounted on its supporting struc-

ture, can be inserted easily through the neck of the bulb; this, in turn, is dependent on the type of socket in which the lamp is to be used. On the other hand, coils in lamps to be used for beam projection either in optical systems or reflectors must be concentrated as much as possible. This introduces additional effects of interchange of radiant energy between different sections of the coil. All of these effects, as well as those due to the kind, volume, and pressure of the gas used in gas-filled lamps, determine the diameter of a filament for a given current and efficiency rating as well as the length corresponding to a predetermined voltage rating.

These factors are combined into two constants, M and C, in the formula:

$$D = MA_{BE}^{2/3}$$

Diameter equals M times amperes at a basic efficiency (BE) raised to a two-thirds power.

$$L = CMV_{BE}A_{BE}^{1/3}$$

Length equals C times M times volts times amperes raised to the one-third power, both volts and amperes at a basic efficiency.

In actual practice the exponents for amperes have been found to deviate slightly from the theoretical values — 0.675 and 0.750 for vacuum and gas-filled lamps respectively in the diameter formula; and 0.3375 and 0.350 respectively in the length formula.

To reduce the current and voltage to a basic efficiency — 10 lumens per watt for vacuum lamps as representing general average for this class, 16 lumens per watt for gas-filled lamps—volt-ampere and volt-lumen characteristic curves have been very accurately determined.

Consequently, numerical values for the two constants (M, C) are a function of the over-all design characteristics of each specific lamp — the mandrel the pitch ratios of the coil as determined by the shape and source dimensions required, the light source and bulb dimensions as determined by the service, the gas filling (or absence of gas) as determined by the wattage, voltage, light source dimensions and efficiency, and the efficiency as determined by the service life expected. These values must be determined experimentally for each new lamp design except when the new lamp is closely related to a previous design or the lamp engineer has considerable experience in the interrelationships of these fundamentals.

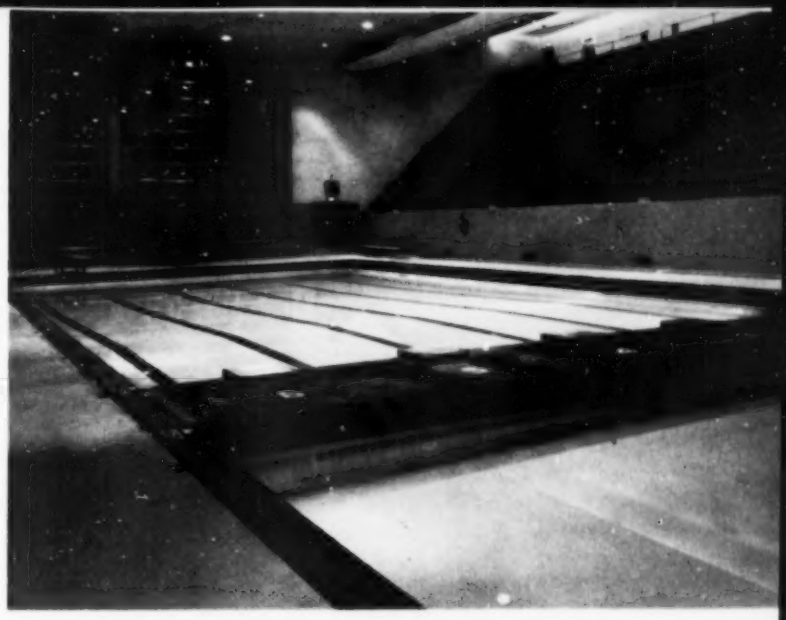
As mentioned earlier, the kind of gas used in gas-filled lamps has considerable influence on the efficiency of the lamp. The lower the thermal conductivity and convection losses of the gas, the less the cooling effect on the filament. This should logically lead to the use of a gas with a minimum in these characteristics. Such gases exist. The so-called noble gases — argon, krypton, and xenon — are inert to tungsten at filament operating temperatures, and have decreasing conductivity and convection losses in the order named. Unfortunately, however, for incandescent filament lamp use, they also have a decreasing ionization potential and are limited as to commercial availability in the same order. (The ionization potential of a gas is the voltage drop through which an electron must fall freely to remove an electron from the atoms. This is a necessary condition for rendering the gas conductive to the flow of electricity.) However, argon has largely displaced nitrogen as a gas filling in all but the higher voltage concentrated filament lamps where arc-over tendencies are prevalent. Even so, it cannot be used in absolutely pure form but must be blended with nitrogen in various ratios depending on the arc-over characteristics of the particular lamp design.

During the past few decades, lamp engineers have learned much about tungsten's idiosyncrasies and have applied their results to filament making — but there still remains much room for improvements. Greater ductility, for example. A tungsten wire with greater hot-strength, and which will develop a stronger non-sag grain structure when burned in a lamp is also desirable. And although much time and effort have been devoted to the wire drawing process, there is still opportunity to improve it to obtain better uniformity in diameter and ductility. Another possibility, of course, always lies in design improvement in the lamp and filament themselves, rather than specifically in the metal.

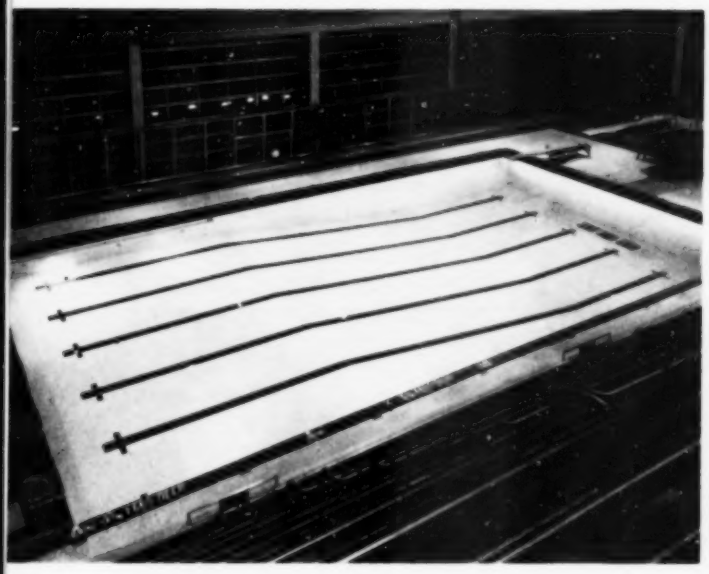
[Editor's Note: This and the preceding article on tungsten are part of a series on the characteristics of materials and services relating to the lighting industry. Previous articles in this series are: "Characteristics of Plastics," December 1951; "Characteristics of Porcelain Enamel," July 1952; "Characteristics of 300-Degree White Baked Enamel Finishes," February 1953; "Characteristics of Alzak Aluminum," March 1953; and "UL — and the Lighting Industry," July 1953. Future articles are planned for acoustical materials, glass, etc.]

See "Installations To See in New York City" — pages 23A and 24A

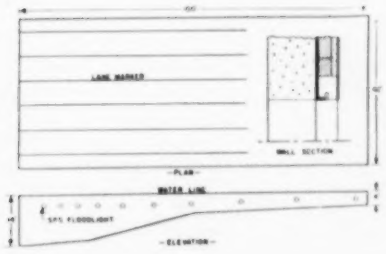
Compare the picture at right and immediately below with the photo at lower right. That's the difference between night and daytime viewing of water sports in the new Syracuse University pool. A unique method of wall construction permitted the use of newly developed equipment, for high level under-water lighting. This supplements the overhead lighting, minimizing objectionable reflections from it, and provides a dramatic setting for underwater events.

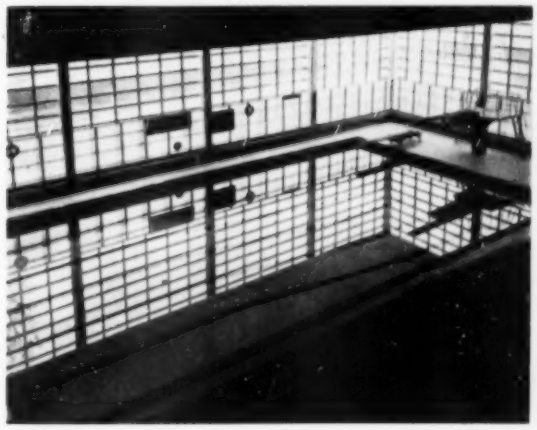


Syracuse University Swimming Pool



In keeping with recommended practice, the spacing of floodlights is closer at the deep end than at the shallow, gradually decreasing from 17 ft to 5 ft (see drawing below). Twenty floodlights each use 500-watt lamps.





A daylight view from the shallow end of the pool (right). Notice the glare off the water at the deep end. Nighttime viewing with both overhead and underwater lights on is considerably more comfortable.

Photos and data supplied by R. H. Goodman, Crouse-Hinds Co., Syracuse, N. Y. This installation won first prize in the contest for My Most Interesting Lighting Job, conducted by Central New York Section, I.E.S.

Proposed Usage of the Words "Luminance" and "Helios"

By GLENN A. FRY

THERE IS a fundamental difference between the concept of flux density (lumens per unit area) per unit solid angle leaving a surface at a given point in a given direction and the concept of flux density per unit solid angle arriving at a given point from a given direction. The name luminance is usually defined in terms of the first concept but is widely used to designate both concepts. It is proposed that the name luminance be retained for the first concept and that the name helios coined by Moon[1] be adopted for general use in designating the second concept.

In each case the flux density (lumens per unit area) is measured or specified in a plane perpendicular to the direction of the flux. The flux density must be uniform in this plane in the region of the point at which the flux density is measured or specified. Also the incoming or outgoing flux must be uniform in the region of the specified direction.

In Fig. 1 let us take an element of area dA_1 at P_1 normal to P_1P_2 and an element of area dA_2 at P_2 normal to P_1P_2 and let us assume that a given amount of flux dF is transferred from dA_1 to dA_2.

The luminance B at P_1 is directly proportional to the total number of lumens (dF_1) leaving dA_1 toward dA_2, divided by the area of dA_1 and the solid angle ($d\omega_1$) subtended by dA_2 at P_1. This gives the number of lumens per unit area per unit solid angle,

$$B = k_1 \frac{dF_1}{d\omega_1 \cdot dA_1} \tag{1}$$

where k_1 is a constant depending upon the units used.

The helios H at P_2 is directly proportional to the total number of lumens (dF_2) reaching dA_2 from dA_1 divided by the area of dA_2 and the solid angle ($d\omega_2$) subtended by dA_1 at P_2. This gives the number of lumens per unit area per unit solid angle,

$$H = k_2 \frac{dF_2}{d\omega_2 \cdot dA_2} \tag{2}$$

where k_2 is a constant depending upon the units used.

AUTHOR: School of Optometry, Ohio State University, Columbus, Ohio.

If we represent the distance from P_1 to P_2 by the symbol r,

$$d\omega_1 = dA_2/r^2 \tag{3}$$

and

$$d\omega_2 = dA_1/r^2. \tag{4}$$

Since dF_1 is equal to dF_2, it follows that

$$B = \frac{dF_1}{d\omega_1 \cdot dA_1} = \frac{dF_1}{(dA_1 \cdot dA_2)/r^2} = \frac{dF_2}{d\omega_2 \cdot dA_2} = H \tag{5}$$

when the same units of length are used to define r, dA_1, and dA_2, and when B and H are both expressed in terms of lumens per unit area per unit solid angle, and also when no correction is made for attenuation by the atmosphere.

Relation Between dF_1 and dF_2

The attenuation of the flux by the atmosphere is one of the principal reasons for drawing the distinction between luminance and helios. The distinction between the two concepts permits one to say that a luminance of so many units produced by a surface at P_1 in the direction of P_2 produces a helios of so many units at P_2 from the direction of P_1.

Allowance for attenuation by the atmosphere can be made. In the case in which the atmosphere is uniform between P_1 and P_2

$$dF_2 = dF_1 (e^{-r\sigma}) \tag{6}$$

where σ is the attenuation coefficient of the atmosphere.

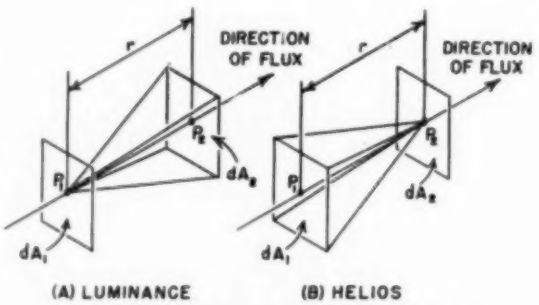


Figure 1. Geometry of luminance and helios.

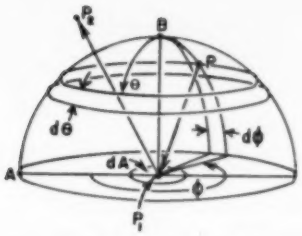


Figure 2. Geometry of illumination at a given point (P_1) on a surface and luminance in a given direction (P_1P_2). ϕ represents the rotation of the half plane of incidence around the normal (P_1B) to the surface from the half plane containing the direction (P_1P_2) for which luminance is to be specified. θ represents the angle of incidence.

Relation Between dA_1 and dA_2

It should be noted in the case of luminance that dA_1 is an infinitesimal area and dA_2 is the base of a pyramidal element ($d\omega_1$) of solid angle with its vertex at P_1, whereas in the case of helios dA_1 is is the base of a pyramidal element ($d\omega_2$) of solid angle with its vertex at P_2 and dA_2 is an infinitesimal element of area.

The Direction of the Flux

Moon[1] proposed that luminance is only a special case of helios, namely the one in which P_2 coincides with P_1, but the fundamental difference is the direction of flux, and selecting a point P_2 closer and closer to P_1 will not reverse the direction. The two concepts cannot therefore be combined into one.

Units

The unit lumen per steradian per square meter and similar units can be used for either luminance or helios.

The nit and stilb are names of units which have been traditionally used as units of luminance. Units like candles per square meter and candles per square foot imply that the flux is directed away from the point at which it is measured or specified and therefore luminance rather than helios is implied.

Blondel is the name of a unit of helios which has been proposed by Moon.[1] Moon proposed to define helios as π lumens per steradian per square meter of projected area, and designated blondel as the unit of helios. This restricts the concept of helios to a single unit. It is possible, however, to define helios as proportional to the flux per unit solid angle per unit area and to leave the proportionality constant and units of flux and length unspecified. The unit blondel on the other hand can be defined as π lumens per steradian per square meter.

The apostilb and lambert units and apparent footcandles are comparable units of luminance which have to be defined in terms of π lumens per steradian per unit area.

Special Uses of the Concept of Helios

The concept of helios is particularly useful in meteorology in dealing with sky brightness measured in a given direction from a given point of observation.

It is of fundamental importance in describing the distribution of helios in the field of view of an eye. The center of the entrance pupil is the point of reference and the lines of sight are the directions in which helios is measured and specified.

The Luminance of a Reflecting Surface

An exact equation for the luminance at the point P_1 on a reflecting surface in the direction of P_2 (see Fig. 2) can be arrived at as follows: Let the point P be any point in the hemispherical space on the reflecting side of the surface. The direction of P from P_1 is specified in terms of the angle of incidence θ and the meridian ϕ with P_1 lying at the center of this system of spherical coordinates. H represents the helios at P_1 arriving from the direction of P expressed in terms of lumens per steradian per unit of projected area.

The quantity ($H \cos\theta \sin\theta \, d\theta \, d\phi$) represents the illuminance dE at P_1 produced by the element of solid angle ($\sin\theta \, d\theta \, d\phi$). This is expressed in lumens per unit area.

The illuminance dE at P_1 must be multiplied by ρ/π to give the luminance dB in the direction of P_2 expressed in lumens per unit solid angle per unit area.

For a given point of observation, ρ is a function of ϕ and θ. The total luminance B at P_1 in the direction of P_2 produced by all the flux arriving at P_1 from all directions is given by the following equation:

$$B = \int_0^{2\pi} \int_0^{\pi/2} \frac{\rho}{\pi} H \cos\theta \sin\theta \, d\theta \, d\phi. \qquad (7)$$

When a surface is a perfect diffuser ρ is constant for all values of ϕ and θ and for all points of observation. In this case Equation (7) reduces to

$$B = \frac{\rho E}{\pi} \qquad (8)$$

where E is the total illuminance produced at P_1 by light arriving there from all directions.

Equation (8) is used to compute B from E even when the surface only approximates a perfect diffuser. This is done in spite of the fact that the

ratio of B to E varies with the distribution of light sources illuminating the surface and the direction of the point of observation.

Definition of ρ

In practice it is customary to determine the value for ρ by illuminating the surface by a single source on a line normal to the surface and measuring the luminance in a direction 45 degrees from the normal. In this case

$$\rho = \frac{\pi B}{E}. \tag{9}$$

The reflectance factor ρ in the case of a perfect diffuser may be defined as the ratio of the total flux dF' reflected from the surface by an element of area at a given point to the total flux dF received by that element of area.

$$\rho = \frac{dF'}{dF}. \tag{10}$$

The total flux (dF) received by an element of area (dA) at the point P_1 in Fig. 3 is the illuminance E at that point multiplied by the area.

$$dF = E \cdot dA. \tag{11}$$

The luminance (B) at P_1 in the direction of P is equal to the number of lumens (dF'') emitted from dA into the element of solid angle ($\sin\theta\, d\theta\, d\phi$) divided by the projected area ($dA \cos\theta$) and the solid angle ($\sin\theta\, d\theta\, d\phi$). This gives the lumens per unit solid angle per unit of projected area.

$$B = dF''/(dA \cos\theta \cdot \sin\theta\, d\theta\, d\phi). \tag{12}$$

The total flux dF' leaving the element of area (dA) at P_1 is as follows:

$$dF' = \int_0^{2\pi} \int_0^{\pi/2} B \cdot dA \cos\theta \cdot \sin\theta \cdot d\theta\, d\phi. \tag{13}$$

Since in the case of a perfect diffuser B is constant for all directions from P_1,

$$dF' = dA \cdot B \cdot \pi. \tag{14}$$

It follows then from Equations (10), (11), and (14) that

$$\rho = \frac{dF'}{dF} = \frac{dA \cdot B \cdot \pi}{dA \cdot E} = \frac{B\pi}{E}.$$

This is true when B is defined in terms of lumens per steradian per unit area and E is defined in terms of lumens per unit area and when dF and dF' are expressed in lumens, ϕ and θ in radians and the same units of A are used for both B and E.

When B is expressed in footlamberts and E in footcandles or when B is expressed in lamberts and E in lumens per sq. cm.,

$$\rho = \frac{B}{E}.$$

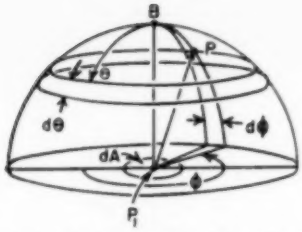


Figure 3. Geometry of the total flux per unit area reflected from a surface at a given point (P_1). ϕ and θ represent the meridian and angle of incidence of the flux reflected in a given direction.

It should be noted that lamberts and footlamberts are here defined as units of luminance and not as units of total reflected flux per unit area.

Radiometric Counterparts of Luminance and Helios

Radiance has already been defined and used as the counterpart of luminance. Moon has proposed the use of the terms radiant helios and luminous helios to differentiate the radiometric and photometric versions of helios. If unspecified the word helios designates luminous helios.

Summary of the Proposals

The concept of luminance and units for measuring it have already been officially recognized by the I.E.S. This is a plea for:

(1) The official I.E.S. recognition of an additional concept, namely, the density of the flux per unit solid angle arriving at a given point from a given direction. This differs from luminance which is the density of the flux per unit solid angle leaving a given point in a given direction.

(2) The official I.E.S. recognition of the name helios to designate this concept.

(3) The official I.E.S. recognition of the blondel unit of helios.

Reference

1. Moon, P.: "A System of Photometric Concepts," *Journal of the Optical Society of America*, Vol. 32, pp. 348-362 (1942).

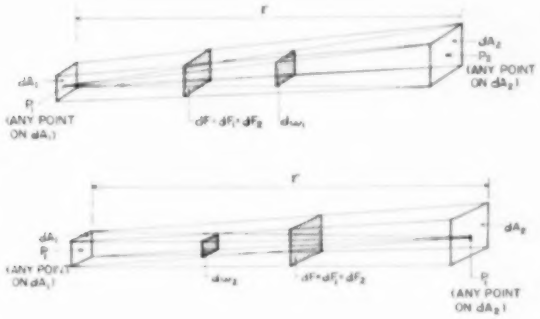
DISCUSSION

D. M. FINCH*: This discussion is for the purpose of clarification of one troublesome concept in radiant energy transfer, namely, the idea of radiation travelling from one small element of a source through a medium to another small element of a receiver. This concept is basic to every situation in which radiant energy (of any wavelength or frequency) is involved. The development of the term and units for this basic building block in the radiation system should

*Chairman, I.E.S. Committee on Nomenclature.

be crystal clear and should stand any test for rigidity or practicality that may be devised for it. Please bear with me then for a somewhat technical critique of Dr. Fry's proposal.

Referring to the paper, "Proposed Usage of the Words 'Luminance' and 'Helios'," the geometry of the system for energy transfer is as shown in Figs. 1 and 2 except that the areas dA_1 and dA_2 should be very small compared to distance r. Also it must be clear that we are dealing with all of the flux from dA_1 to dA_2. This means that dF_1 has to equal dF_2 since we are only considering the flux that leaves all points on dA_1 and arrives at all points on dA_2. The point, P_1, must be thought of as moving to all parts of dA_1 and the point, P_2, as moving to all parts of dA_2. The geometry might be clearer by redrawing Figs. 1 and 2 as follows.



From the geometry and the physics of radiant energy it may be postulated that the flux (dF) from dA_1 to dA_2 is proportional to the area density of the radiation at dA_1 and the space density in the region between dA_1 and dA_2 so

$$dF = \text{constant} \cdot dA_1 \cdot d\omega_1$$

or

$$dF = \text{constant} \cdot dA_2 \cdot d\omega_2$$

The constant may be considered a basic property of the radiation transfer and is defined as:

$$\text{constant} = B = \frac{dF}{dA_1 \cdot d\omega_1} = \frac{dF}{dA_2 \cdot d\omega_2} \qquad \text{(a)}$$

Equation (a) is the definition of photometric brightness, B, when the flux is luminous flux. One might elect to call the term by another name such as "luminance" or "helios" but it would not change the concept and it would not lead to a simplification of terminology. The concept is a definition of a *fundamental property* of the energy transfer between two elements of a system and therefore should be defined in terms of both the source and the receiver.

If there is scattering or attenuation equation (6) applies. Such a condition destroys the original assumptions for equations (1) through (5). The attentuation has to be taken into account where it applies but should not be considered in the basic derivations.

The units for the basic concept should be in terms of the dimensions, namely, flux per unit area per unit solid angle. In the U. S. the convenient dimensions are lumens per square inch per steradian which corresponds to candles per square inch. Other units based upon the meter or centimeter would be equally satisfactory. For some purposes it is convenient to have a unit that is πB in size. This unit should not have the same symbol or name but might be called *uniform*, *average* or *equivalent brightness* as has been proposed previously.

The factor ρ/π may only be used if the surface is perfectly diffusing. This is not an essential condition for defining reflectance or photometric brightness (luminance).

Equation (7) is only valid for a diffuse surface since ρ/π incorporates this assumption. Equation (8) therefore only applies to a diffuse surface as indicated. In this case the quantity, $\pi \times B$, implies *uniform* brightness.

The reflectance should be defined exactly as the flux reflected divided by the flux incident on a given area as shown in equation (10). There should be no restriction on the surface, or the direction or the quality of the source.

A *brightness factor* is an entirely different term and may be used to equate photometric brightness to illumination:

$$B = \text{B.F.} \times E$$

The *brightness factor* will depend upon the surface characteristics, the direction of the source and observer and the quality of the light.

In the first paragraph under "Definition of ρ," the method is only one of many techniques for evaluating reflectance. The value will depend upon the method of measurement. The latter should be stated whenever the reflectance is reported.

Equations (11) through (13) all pertain to diffuse surfaces. For this special case the equations are correct but the definition of ρ should not be construed as general.

Radiance is the radiometric counterpart for what I have called *photometric brightness* and what Fry terms either *luminance* or *helios*. There should be such an equivalence but it should apply to a single photometric term. For illuminating engineers we should use *photometric brightness*.

I submit, one term (*photometric brightness*) with a single definition will suffice to clear up the whole system of nomenclature.

GLENN A. FRY*: I have proposed that the term "luminance" be used to designate flux per unit of projected area per unit solid angle leaving a surface, and that the term "helios" be used to designate the flux per unit of projected area per unit solid angle arriving at a given point. What names are used is unimportant but it is claimed that these two things merit separate names.

Finch has proposed that since the units used for these two things have the same dimensions, these two things ought to be regarded as identical and designated photometric brightness.

Finch also points out that in the case of flux transferred from a source to a receiver, we are dealing with the same flux which is simply transferred from an element of area in one plane to an element of area in another plane. Even in this situation, different elements of area, and different elements of solid angle are involved in the definition of helios and luminance. In addition to this, there is to be considered the attenuation of the flux by the medium between the two elements of area.

The need for two different names is even more acute in the case of reflection of light by a surface. The name helios can be used to describe the flux arriving at a given part of the surface from a given direction. The word luminance can be used to describe the fraction of this flux which leaves the surface in some specified direction.

The fact that the units used for measuring these two things have the same dimensions may justify using a single symbol, say, B, to designate both things, but an unprimed B could be used to designate flux incident at a point from a given direction and B' could be used to designate flux leaving a point in a given direction.

*Author.

If Finch objects to the use of two names for a thing involving units of the same dimensions, he should be consistent and recommend that only one name and only one symbol be used to designate both illuminance and emittance. The problem is exactly analogous to that of helios and luminance.

When I made my proposal, I was aiming at keeping the changes in standard nomenclature down to a minimum, but since Finch is considering such a sweeping reform as to go back to the use of the term photometric brightness as a substitute for the now accepted term luminance, it may be just as well to consider the problem from the point of view of a generalized scheme of nomenclature.

One of the reasons for avoiding the word luminance is the poor phonetic differentiation of luminance from illuminance, and also the suggestion of some fundamental connection between the meaning of luminance and the meaning of illuminance, in which illuminance might be regarded as a special kind of luminance.

It would simplify matters to use a couple of words with the same root but with different prefixes to designate what I have called helios and luminance. The same thing applies to illuminance and emittance, and this would be consistent with using unprimed and primed symbols to designate these pairs of things, such as B and B' and E and E'.

The words, imbrightnance and exbrightnance, could be used, for example, to designate the things I have called luminance and helios. Imbrightnance and exbrightnance could be regarded as two kinds of brightnance, and the suffix "nance" would differentiate brightnance from brightness which could still be used to designate subjective brightness.

The words inheliance, exheliance and heliance would be much more euphonic and would be more consistent with the present trend in terminology than inhelios, exhelios and helios.

In the case of illuminance and emittance, the word exluminance might be substituted for emittance. The words illuminance and exluminance would come to be regarded as two varieties of luminance. There is no immediate need for dropping the word emittance. Eventually exluminance might be substituted for it, but before then the word luminance as it is currently used should be allowed to die a natural death.

As pointed out by Finch radiometric and photometric concepts should parallel each other. The same confusion exists between radiance and irradiance as between luminance and illuminance and a new term or pair of terms should be found for radiance. For want of a shorter term one might speak of radiant heliance in the same way as radiant emittance.

Finch has gone further than I have gone in advocating that the lambert unit be defined as a unit of emittance. This I accept as being in the right direction. The definition of the lambert as a unit of emittance makes possible a much more rigid definition of luminance and helios because in this instance, luminance or helios can be defined as equal to and not merely proportional to flux per unit projected area per unit solid angle. If helios is defined in this way, the blondel unit as defined by Moon would not be satisfactory for designating helios since it incorporates a π factor.

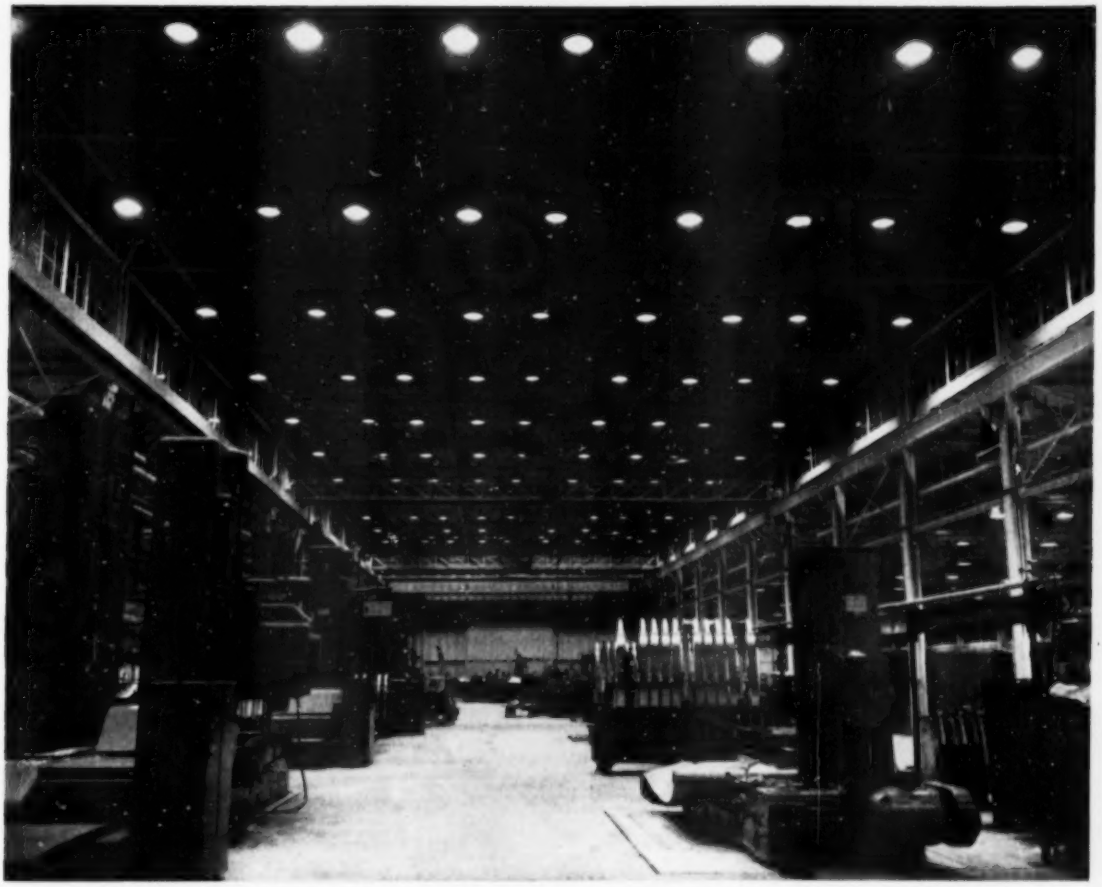
In regard to the definition of reflectance, it seems to me there are two things which can be differentiated. On the one hand, we have a factor which expresses the relationship between the flux arriving at a surface at a given point from some given direction and the fraction of this flux leaving the surface in some given direction. On the other hand, we have the ratio of emittance to illuminance.

The two types of reflectance should be differentiated by two different symbols and by two different names. Reflectance should continue to be defined as the ratio of L to E, and a new name should be coined for the other type of reflectance.

Finch's differentiation between reflectance ρ and the brightness factor of ρ/π is well taken and is in line with the definition of the lambert as the unit of emittance.

Modular Lighting Used in Bank

Two- and four-lamp instant-start module units were employed at the Brookline Savings and Trust Company, Pittsburgh, to create a uniform appearance, while allowing variation in footcandle level. In the working area, the four-lamp units supply 65 ft-c and in the traffic area two-lamp modules provide 52 ft-c. The 48 x 16-inch units combine to form 4 x 4-foot panels. Installation was designed by E. J. Dunlap, Duquesne Light Co. and installed by Haubelt Electric Co. Photo and data submitted by A. G. Caplan, Duquesne Light Co., Pittsburgh.



INSTALLATION AT AXELSON MANUFACTURING COMPANY, 7701 ANAHEIM TELEGRAPH ROAD, MONTEBELLO, CALIFORNIA.

High-Bay Industrial Lighting

LIGHTING OBJECTIVE: To provide general lighting suitable for general machine shop and assembly work in a high-bay area.

GENERAL INFORMATION: The central crane area shown above measures 60 feet wide with a 31-foot mounting height. Bays between trusses are 20 feet deep (total length 280 feet). Machinery reflection factors are 20 to 30%, the floor and structural iron are about 35%. Supplementary local lighting is available for individual close machine tool work as required.

INSTALLATION: Westinghouse #789585 luminaires containing 400-watt J-H1 color-corrected mercury vapor lamps and #889905 units with 500-watt incandescent filament lamps are installed as indicated in Fig. 2. Both units have a medium concentrating distribution. The incandescent units were installed to minimize stroboscopic effect and provide illumination in case of power failure.

(over)

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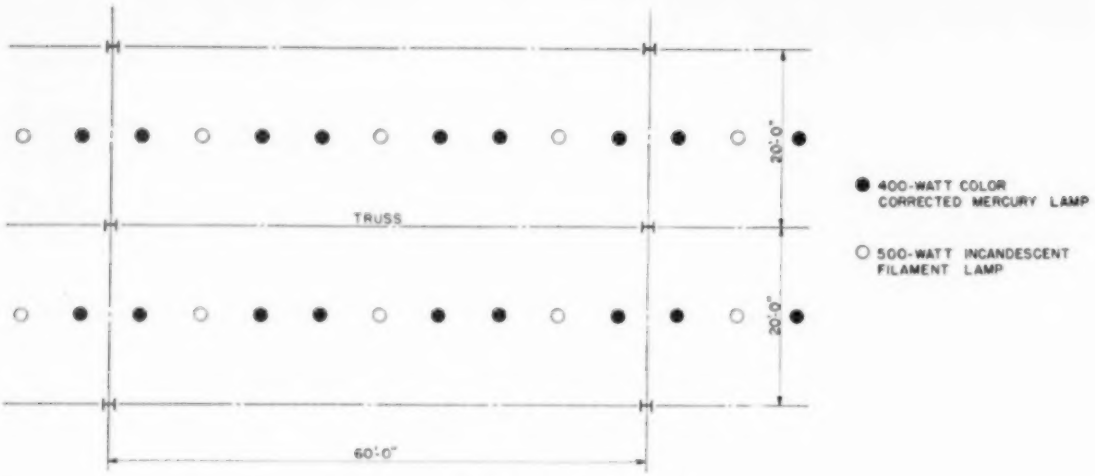

Figure 2. Plan view of two bays.

After three months of continuous operation the illumination on the machine tools averaged 45 footcandles.

Luminaire shielding angles are as follows:

Mercury unit	
from light center	40 degrees
from bottom of source	35 degrees
Incandescent unit	
from light center	45 degrees

Lighting data submitted by F. E. Blair, Westinghouse Electric Supply Co., 905 E. Second Street, Los Angeles, as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Recommended Practice for Residence Lighting

Prepared by the Committee on Residence Lighting of the Illuminating Engineering Society

Foreword

In June 1945, the Illuminating Engineering Society issued for the first time a Recommended Practice of Home Lighting which was reprinted with minor revisions in 1947. In 1946 extensive research and tests were completed for the publication of "Lighting Performance Recommendations for Portable and Installed Residence Luminaires." Late in 1950 another important publication "Contemporary Lighting in Modern and Traditional Interiors" was completed and published. This was purposely a less technical report since its first purpose was to assist allied professions to coordinate modern illuminants with all styles of interior decorative treatment.

These publications stimulated studies by individual Committee members of specific home visual and lighting problems. The reports of these studies formed the basis of further Committee investigations and a report, published in July 1951, under the title, "The Functional Visual Activities in the Home and the Extent and Location of Associated Areas to be Illuminated."

From this growing framework of technical data and of clearer definition of the home and family lighting problems, this edition of the Recommended Practice for Residence Lighting was developed. It represents an enlarged treatment of the subject and is specifically directed not only to Society members but to residence architects, equipment and interior designers, and educators.

I.E.S. Residence Lighting Committee

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Norman H. Vacha, *Vice-Chairman*

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Myrtle Fahsbender	Priscilla Presbrey
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Caroline Horn	Mary Taepke
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Recommended Practice Sub-Committee

Jan Reynolds, *Chairman*

E. W. Halteman	Yvan L. Ripley
Caroline Horn	Orpha Mae Thomas
Priscilla Presbrey	Mary E. Webber

1. Introduction

1.1 — *Scope* — This text is mainly devoted to basic lighting requirements for family activities which involve close vision. It considers no fundamental difference between the farm and the city dwelling, between the pretentious and the modest residence. The lighting method and appearance of equipment may vary for appropriate harmony with the decoration, costs and use of the specific interior. (While recommendations on style, fashion and artistic design are outside the professional responsibility of the Illuminating Engineering Society, these factors must be fully considered in any appropriate lighting solution.)

1.2 — *Concept* — **(a)** Family living consists of the daily performance of many household, recreational and social activities requiring sight. Light activates the physiological processes in the eye, giving rise to the sensation of sight.

(b) Reading and study in the home is much the same visual problem as in offices and schools. Sewing, handcraft hobbies, and many household duties are no less exacting, although perhaps less continuous, than similar visual tasks in industry. The design of residences, however, cannot utilize, except in basic principle, the lighting techniques acceptable in public interiors. The near-uniformity of light distribution employed in schools and offices is usually incompatible with the intimate living intent of most residential interiors. However, the home may be dramatized by lighting effects similar to those used in the theater, restaurants and churches. The relatively smaller areas involved in residence living space require adjustments in the scale, weight and detail-treatment of luminaires. The tastes and varying eyesight demands of the individual family necessitate various lighting effects.

Approved by the Council of the Illuminating Engineering Society June 10, 1953.

1.2.1 — *Trends in House Design* — Residences are undergoing a marked change. Economic changes have brought about reduction in space, in total areas as well as in ceiling heights, with a consequent trend to more open interior planning with increased fusion of the interior with its natural outdoor environment. Leading housing specialists and home economists stress integration of plan for more comfortable, livable and workable use, based on how the family lives. The goal is a higher standard of actual *performance* in those elements which are essential for health, safety, and satisfaction in the dwelling and its environment.[1,2] Contemporary lighting reflects these trends by providing illumination subjectively for the persons occupying the home rather than objectively lighting specific rooms.

1.2.2.—*Family Living Patterns* — The technological, social, and economic changes of the past decade are influencing American living habits. There is great increase in informality and naturalness in living patterns. Multiple use of the decreasing space in the great majority of the new homes is a necessity. For example, many homes do not have a separate dining room, and the dining table is used also for games, hobbies, sewing, and a place to study. The sleeping area often becomes an all-purpose room for grooming, reading, studying and sewing. These conditions require versatile and specifically planned lighting to meet the visual needs of all members of the family throughout the residence.

TABLE I.—Illumination Values for Residences.

(A) Specific Visual Tasks.

These illumination values aim to fit the light to typical home tasks for persons with normal vision, with due consideration to such matters as cost and practical attainability. They do *not* represent the optimum, since under some conditions more light may be necessary, desirable and attainable. The recommended values may be obtained from portable lamps or from special purpose equipment designed for the specific function, or from a combination of local and general lighting.

Specific Visual Tasks	Area To Be Lighted[a]	Footcandles on Task (Current Recommended Practice)[b]
Reading		
Prolonged Periods (smaller type)	14″ wide x 12″ high	40
Casual Periods (larger type)	14″ wide x 12″ high	20
Study	14″ wide x 12″ high	40
Reading Piano Scores		
Advanced (scores with grace notes and fingering notations for complex chords. When score is sub-standard size, and notations are printed on the lines, 100 footcandles or more are needed.)	18″ wide x 12″ high	40 or more
Intermediate (average scores having notations beside musical notes	18″ wide x 12″ high	20
Elementary (simplest scores for beginners)	18″ wide x 12″ high	10
Writing	14″ wide x 12″ high	20
Sewing (Hand)		
Dark Fabrics (fine detail, low contrast)	10″ x 10″	150 or more
Prolonged Periods (light to medium fabrics)	10″ x 10″	80
Occasional (light fabrics)	10″ x 10″	40
Occasional (coarse thread, large stitches, high contrast thread to fabric)	10″ x 10″	20
Sewing (Machine)		
Dark Fabrics	6″ x 6″	150 or more
Medium Reflectance Fabrics	6″ x 6″	40
Light Fabrics	6″ x 6″	20
Kitchen Duties		
At Sink	40″ wide x 24″ deep	40
At Range	48″ wide x 24″ deep	40
At Work Counters	24″ wide x 20″ deep	40
Laundry		
At Tubs	48″ wide x 20″ deep	40
At Ironing Board	40″ wide x 12″ deep	40
At Ironer	30″ wide x 14″ deep	40
Grooming		
Shaving at Bathroom Mirror	Two planes[c] at right angles to each other 8⅝″ wide x 6″ high plus a 12″ x 12″ plane[d]	40
Make up at Dressing Tables and Dressers	Two planes[c] at right angles to each other 8⅝″ wide x 6″ high	20
Figure Viewing at Full-Length Mirrors		
Critical Inspection	20″ wide x 54″ high	40
Casual Appraisal	20″ wide x 54″ high	20
Handcraft		
At Work Bench	48″ wide x 20″ deep	40
Game Table		
Card Table	30″ x 30″	10
Table Tennis, Recreational	5′ x 9′	20

[a] The location of these areas in relation to the eyes of the user and to the furniture is detailed in Section 4.

[b] The values listed for specific visual tasks represent an average of at least five measurements made on the work surface with the light-sensitive cell or test plate on the same plane as the work. The highest of the several readings should be not more than five times the lowest. Where two or more of the designated tasks are carried on at one location, provision for the more difficult one should be made with or without an arrangement for the other levels through switching or dimming.

[c] Representing each side of the face.

[d] Representing top of the head.

(B) General Lighting.

The values given for general lighting are intended to assist in achieving desirable brightness ratios. They are based on the assumption that interior finishes are within the recommended limits of light reflection (2.2.1). In those places where close visual application is not involved, the lighting levels listed aim to assure safe passage and attractive lighting atmosphere.

These values may be attained by general lighting methods (see Section 5) or by a combination of general and local lighting luminaires.

General Lighting	Footcandles (Current Recommended Practice)[e]
Entrance hall, stairway and stair landings	5
Living room, library, sunroom	5[f]
Dining room	5[f]
Kitchen	10
Bedroom	5[f]
Bathroom	5

[e] Average of at least six readings taken throughout the room on a plane 30 inches above the floor, with the light-sensitive cell or test plate held in a horizontal position. No reading should be taken closer than 30 inches to a portable luminaire or 15 inches to any wall.

[f] When specific visual tasks are lighted with 40 ft-c or more and have relatively high reflectance (60% or higher) a general lighting average value of 10 footcandles is desirable.

2. Objectives of Residence Lighting Design

2.1 — ***Comfortable Seeing Conditions*** — The common usage of the simple words, "light," "vision" and "seeing," often obscures their effect on human well-being. Seeing[3] is a complex activity performed with two essential tools: light and vision. Always interrelated are the task, the light essential to make that task visible,[4] and the sensation experienced by the person performing the task. The sensation may be one of ease or difficulty, comfort or discomfort. The determining factors are the difficulty and the duration of the seeing endeavor (Appendix A*), the condition of eyesight (Appendix B), and the character of the lighting. Although individuals vary greatly, certain fundamental lighting requirements are basic for visual function and comfort. Specific illumination values in footcandles fitted to the character of the task must be delivered to the task or the location where it is placed. These amounts prove acceptable to most persons only when other fundamental conditions are met: (1) proper distribution of the light on the task and in the surroundings, (2) minimum reflection of light sources from glossy surfaces and (3) close relationships (brightness ratios) of brightness values (footlamberts) between the task and the field of view.

2.1.1 — *Illumination Levels* — Table I (A) lists the most common home tasks that involve critical vision, typical task areas, and the recommended illumination for each. These levels apply for either indoor natural lighting or artificial lighting. Near a window on a clear day, they will generally be exceeded. At moderate distances away from windows, however, additional electric light sources are usually required to obtain them. Equal visibility over a given task area is most nearly approached by uniform illumination. However, for reasonably good distribution, the highest of at least five illumination measurements over the task area should not be more than five times the lowest. Measurements are commonly made near the four corners and center of the task area. Appropriate luminaire design can provide the desired distribution if the luminaire is placed so that no part of the user's body or other obstruction is between the luminaire and the task. Lighting which is delivered primarily to a visual task is referred to as *local lighting;* lighting distributed primarily throughout an interior is called *general lighting.* The average illumination values to be maintained in the typical living areas are given in Table I (B) and are discussed further in Section 5. The stated levels are based on interior finishes as recommended in Section 2.2.1.

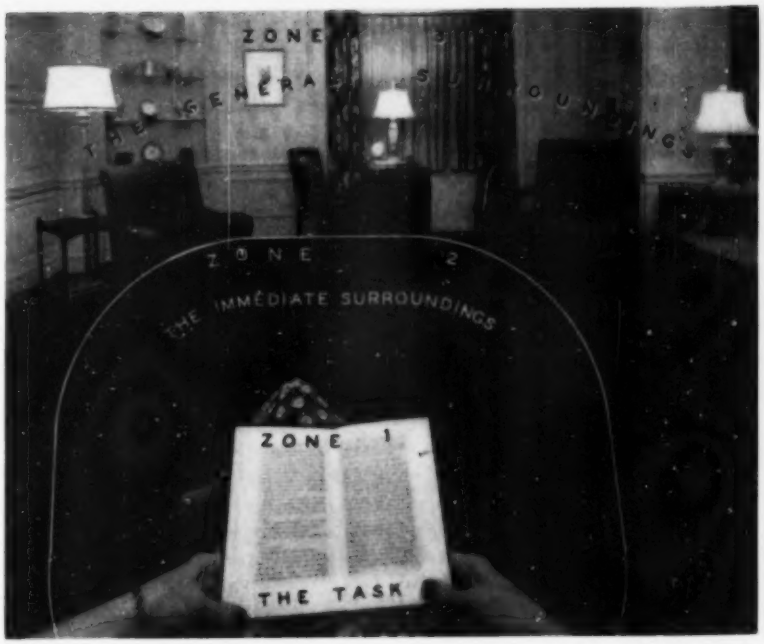


Figure 1. Camera placed in eye position shows the general magnitude of the visual zones for reading a book. The reflectances of major interior surfaces as well as lighting design determine the brightness ratios between zones. (Section 2.1.3)

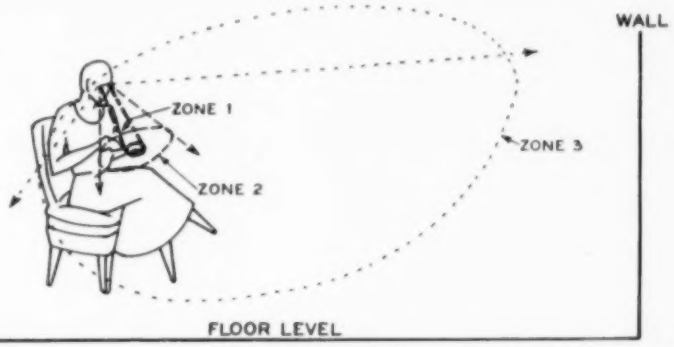


Figure 2. This drawing shows the approximate limits of the visual field and the relative size of the three zones when the head is bent forward and the eyes are fixated on a small task. As the eyes or head move, the gaze shifts from zone to zone.

2.1.2 — *Field of View* — For lighting analysis purposes, the field of view or visual field is considered to be divided into zones[5] about the line of sight. These zones are roughly cone-shaped with the apex at the eye, Figs. 1 and 2. Zone 1 includes the area of the task, which varies in extent with the activity as dimensioned in Table I (A). While critical seeing is done in a very small spot at any one time, the eyes move and fixate over the entire area for the performance of the task. Zone 2 includes a limited area immediately surrounding the task; it is

*See reprint for all Appendixes.

approximately a 60-degree cone, the center line of which coincides with the line of sight. Zone 3 includes the remainder of the surroundings that fall within the field of view.

2.1.3 — *Brightness Ratios in the Field of View* — **(a)** The subject of brightness patterns as they provide visual comfort and visual effectiveness is of primary importance to lighting designers in all fields of application. Growing information is developing as studied analyses of installations and basic research continue. At present it is considered that the most satisfactory and comfortable lighting results — for periods of close visual activities—are attained when the following brightness relationships within the visual field guide the lighting plan. The task brightness is considered the basis for recommended brightnesses within its surround. Typical average brightness values of home tasks (attained in Zone 1 from the illumination levels in Table I A) range generally between 12 and 30 footlamberts. They seldom exceed 50 with present day equipment and techniques. Brightnesses in Zone 2 which are either noticeably greater than those of Zone 1, or are less than about one-tenth as great, contribute to discomfort and are in general distracting. As the task brightness increases or as the duration of the task lengthens, a lower ratio becomes desirable. Substantial areas of brightness in Zone 3 should not materially exceed ten times that of Zone 1 or be appreciably less than about one-tenth of it.

(b) Visual comfort and effectiveness are also influenced by a task which has a glossy or specular surface. Limited areas of such a task may reflect the much brighter image of the light source or luminaire. Such glaring reflections cannot always be completely eliminated. Reduction of the light source or luminaire brightness or more careful placement of the source (or the task) will alleviate the condition (Fig. 7). Reflected images are further "softened" if part of the light on the task comes "indirectly" from walls, ceilings, or other luminaires.

2.2. — *Livable Environment* — Fundamental, also, in the design plan is the overall impression created by the environment. It must "feel" in harmony with those basic aesthetic and emotional sentiments associated with the home. The suggested brightness patterns avoid monotonous "even" light, and permit interesting interplay of light and shadow. For areas used for activities which do not involve close vision, illumination levels are less critical and substantially higher brightness ratios may be employed. Scintillating, exciting effects, or more subdued, intimate ones, may be geared to the desired mood.

TABLE II.[7]—Appearance,[a] Reflectance and Munsell Designation of Selected Samples of Surface Colors.[b]
"House and Garden" Color Samples for 1949-50.

Color Name	Appearance with "Daylight" Illuminant [c]	Reflectance %	Munsell Designation	Appearance with Incandescent-Filament Illuminant [d]	Reflectance %	Munsell Designation
Carnation	PINK, cool	60	5YR8/7	PINK, cool	63	5YR8.2/12.5
Ruby	RED, cold (toward blue)	12	7R4/13	RED, orange vivid	15	8.4R4.5/16.5
Flame	RED, cool	30	7.5R6/14	RED-orange, strong	34	9R6.3/18
Sweet Pink	PINK, slightly bluish	66	4.5YR8.3/7	Yellow-PINK, warm	70	3.5YR8.5/13
Citron	YELLOW—slight green cast	74	3.5Y8.8/8.5	YELLOW, warm, pale	78	8.5YR9/14
Mustard	YELLOW—slight orange cast	44	2Y7/10	ORANGE-yellow—no green	47	7.5YR7.3/14
Avocado	GREEN-yellow	22	1.5GY5.3/5.8	GREEN—brownish cast	22	2.5Y5.2/8
Sprout	GREEN-yellow	60	1GY8/8	YELLOW-GREEN, dull	60	2.5Y8/11
Leaf	GREEN	13	10GY4/5.2	Medium GREEN—yellow cast	12	3.5GY3.9/5.5
Kingfisher	BLUE-GREEN	34	10GY6.3/3.7	Yellow-GREEN, grayed	32	7.5Y6.1/5
Forest	BLUE-GREEN, deep	6	9.5GY3/2.5	Yellow-GREEN, deep	7	1.5GY3/3.6
Willow	Blue-GREEN—grayed	39	7Y6.7/4.5	Grayed GREEN—yellow-red cast	39	10YR6.7/9
French Blue	BLUE—no cast	42	4GY7/1.5	BLUE, warm, no red	41	8.5YR6.8/6
Heather	Red-PURPLE	44	10R7/4.5	Orange-PINK, slightly dull	45	3YR7/9.5
Hyacinth	BLUE-purple	38	5YR6/1.25	GRAY—Warm yellow cast	38	7.5YR6/5.8
Bright Navy	BLUE-purple cast	8	2.5PB3.3/9	BLUE—gray, low in color	6	1.5Y2.8/2.2
Copper	BROWN-orange	20	3.5YR5/9	ORANGE-RED	22	2.2YR5.2/13.5
Sandalwood	BROWN—tinged red	32	7.5YR6.2/6	YELLOW—red-brown	33	5.5YR6.3/10
Chocolate	Red-BROWN—purple tinged	11	5YR3.7/4.2	Yellow-RED BROWN, warm	11	5YR3.8/7.8
Parchment	GRAY-yellow	50	2.5Y7.4/5.5	Yellowish GRAY	52	8.5YR7.6/10.5
Stone	GRAY, warm	42	10YR7/4	Reddish GRAY, warm	43	7.5YR7/9
Pewter	GRAY—blue cast, cool	31	2.5Y6/3.5	Warm GRAY	31	9YR6/8

Winsor and Newton Ltd. Artist Colors

Color Name	Appearance with "Daylight" Illuminant [c]	Reflectance %	Munsell Designation	Appearance with Incandescent-Filament Illuminant [d]	Reflectance %	Munsell Designation
Cadmium Yellow	YELLOW, cool	50	7.5YR8/15.5	Orange-YELLOW	56	4.5YR7/17
Chrome Orange	ORANGE	25	1.7YR5.5/14.5	ORANGE-RED	28	1.9YR5.8/16.5
Vermilion	RED-orange, slight cold cast	17	9.2R5.6/13.5	RED-Orange	20	8.5R5/18
Green	GREEN	15	9GY4.4/6.5	YELLOW-GREEN	14	4GY4.2/6.3
Green	GREEN, deep, slightly bluish	9	9GY3.4/3.75	GREEN—deep, warm	8	10Y3.2/4
Alizarin Crimson	Blue-RED, deep	7	7.5R3/9	Brown-RED, deep	7	9.5R3.1/11.5
Cobalt Blue	BLUE, clear	7	7.5PB3.1/10	BLUE, deep	6	7.5PB2.8/5
Ultramarine Blue	BLUE-purple, deep	4	9PB2.2/12	BLUE, purple	4	2P2.4/4

[a] Verbatim repeat of word description for a given sample color means that they are essentially identical in appearance.

[b] The incident illumination on the samples — 35 footcandles.

[c] Incandescent-filament lamps with color correction filters were used to obtain an approximation of natural daylight at a color temperature of 4370K. This is considerably warmer than daylight color matching units near 6500K, which has no acceptance in residence interiors. The color temperature of cool white fluorescent lamps is also approximtaely matched by this source.

[d] The color temperature of this light source is 2845K, close to that obtainable with 75- and 100-watt inside frosted lamps — and to that of warm white fluorescent lamps.

There are, however, marked differences in most cases in the color rendition under the above illuminants and the corresponding warm or cool fluorescent lamps.

2.2.1 — *Interior Finishes and Reflectances* — **(a)** A well-designed lighting system cannot be planned independently of the color and character of the surfaces it is to illuminate. The effect attained depends upon the way the large surfaces within an area reflect and absorb the light. Thus walls, ceilings, floors and major furnishings become an integral part of the lighting design. If large areas have a high sheen or glossy finish, specular "mirrorlike" reflections of light sources may be distracting or even uncomfortable. Dull or matte finishes are therefore desirable. The following ranges of reflectance are suggested:

Ceilings	60% - 90%
Walls	35% - 60%
Floors	15% - 35%

(b) Somewhat wider reflectance ranges than in other fields of lighting are possible in residences where the lighting qualities to be achieved are more varied. Values at the higher end of the suggested ranges for ceilings and walls are more important in utility rooms where efficiency in a lighting system is often of greater significance. However, wall reflectances appreciably higher than 50 per cent often create problems of excessive wall brightness in those rooms where portable luminaires are placed near the walls or where extensive wall lighting methods are used. In any area in which the major luminaires depend largely on ceiling reflections for their effective performance, the ceiling reflectance should be 70 per cent or more. Since sections of the floor form a considerable portion of Zone 2 for many visual tasks, the middle and higher floor values are encouraged. With lower reflectances than suggested, it is very difficult to attain recommended brightness ratios. Besides, with low reflectances, lamps of the lumen output required to achieve higher illumination often cannot be contained in luminaires appropriately scaled for residence interiors.

(c) Pure colors of the highest saturation, except in the yellow region, have low reflectance. The level of reflectance varies with the hue. Reflectance values also change with the color quality of the light source, although this change under "white" light is relatively insignificant except when the light source is lacking or highly deficient in the dominant color of the surface being illuminated. These facts are all shown in Table II, which gives the individual reflectances of eight basic spectral hues at full saturation (represented by the artist colors of high purity made by Winsor and Newton Ltd.). Colors of the purity of the Winsor and Newton group are not used on extensive areas; however, more appropriate residence colors—through mixture with white, black and other hues — vary over a wide range of reflectances, as represented by the *House & Garden* colors in Table II. The relatively higher reflectance of yellow makes it particularly suited to use on ceilings when high chroma is desired and high reflectance needed. However, light which is reflected from a colored surface is also modified by the color of the surface. For example, in a room where considerable light is reflected from a *greenish*-yellow ceiling, flesh tones will have a sallow cast. An *orange*-yellow ceiling of the same reflectance would give more flattering results.

(d) With the contemporary use of higher chroma colors, it is necessary to select finishes for rooms where extensive visual work is performed with careful attention to reflectance. This need not result in "washed out" or uninteresting "grayed" colors as the inserted color chart* illustrates. While not a color recommendation, this chart shows a range of colors which have reflectances within the suggested ranges for floors, walls and ceilings. In all, eight colors, representative of the full spectrum, as well as two neutral hues were selected for wall application. Subtraction or addition of white in varying proportions, depending on the value and chroma of the selected wall color, creates suitable reflectances for floors and ceilings. In the case of some "floor" colors, another hue was added.**

*Color chart will be inserted in the reprint of Recommended Practice for Residence Lighting for distribution in booklet form.

**Color Terms:

Hue — Refers to a color family, a basic color as it appears in the spectrum. A dark red and a light pink are the same hue.

Chroma (saturation) — A term used to designate the strength of a color as it extends from a gray of the same value to the greatest saturation of the color.

Value (lightness) — Refers to the tonal quality of a color from light to dark. It is determined by comparison with a graduated scale from black to white. In the natural order of the spectrum, yellow is the lightest in value and blue-violet the deepest.

2.2.2 — *Effect of Light on Color* — The appearance of colored surfaces undergoes change with both amount of light and spectral (color) quality of the light. Low illumination levels result in a grayed, less colorful appearance. Dissatisfaction with home color schemes often stems from the fact that they are selected under high levels of daylight and then when viewed in the home, under the much lower levels of electric light, they appear dull by comparison and seemingly of a different color. The color change may be due also to the differences in color composition or quality of light between natural and electric light sources. Both vary over a wide range from reddish or warm white to bluish or cool white. A higher proportion of blue and green is present in daylight and in fluorescent lamps* than in the light from incandescent-filament lamps.* In the latter, the proportion of yellow-red is greater. How this shift in light quality affects colors in hue, value and chroma is indicated in Table II. (See Section 3.2.)

2.2.3 — *Use of Colored Light* — Colored light is obtainable from colored incandescent-filament lamps, or more efficiently from colored fluorescent lamps. Colored glass or gelatins may be placed over incandescent lamps. Obviously, the resultant light will distort the appearance of color in the decorative scheme. In general, the application of colored light should be limited to special decorative or party effects, and usually is most appropriate in recreation or outdoor areas. Deep colors in major portions of the luminous parts of luminaires are to be avoided, although pale tints are not objectionable.

2.3 — *Safety* — A large number of home accidents are the result of poor or slow seeing. It is vital that the lighting and switch control[8] plan afford sure and quick seeing from room to room as well as at all danger locations, such as stairs, medicine cupboards, and equipments with moving parts. Members of the family who awake in the night often wish to move about without disturbing others by turning on normal lighting. Low-wattage night lights of the type that may be plugged into convenience outlets are suggested for bath, bedrooms, passageways and near the top of stair-

*Commonly called "bulbs" or "tubes."

ways. For dark-adapted eyes, these lamps provide sufficient light for movement with relative safety. Indoor switch control and strategic location of yard and driveway floodlighting prove excellent protection against prowlers. (See Section 4.9.)

2.4 — ***Special Decorative Effects*** — The ways in which light can be used purely for decorative effect are limited only by the ingenuity of the designer, or by cost. The purpose is solely to attain artistry in effect, or to enhance the beauty in form, color, texture and line of structural elements, sculpture, paintings and other art objects. Such applications often prove functional also. The lighting of recessed book shelves or niches, for example, increases the brightness of otherwise dark areas, thus improving brightness ratios. Any area which reflects light contributes to the overall effect. The detailing of methods and ideas for lighting accent has been well treated elsewhere.[9,10]

3. Selection of Light Sources

3.1 — ***Choice of Incandescent-Filament or Fluorescent Lamps**** — The choice between incandescent-filament or fluorescent lamps is influenced by the physical characteristics of the two sources, and by relative installation and operating costs. The incandescent-filament lamp is the more concentrated small, high-brightness source, readily controlled by relatively small luminaires. For comfortable brightness, filament lamps require the use of adequate shielding, directional control, or highly diffusing materials. The fluorescent lamp is a larger-area low-brightness source, and its shielding requirements are less stringent than those of the filament lamp for equivalent brightness. Fluorescent lamps are much more efficient than filament lamps, producing from 30 to over 50 lumens per watt including ballast, as compared with 10 to 17 lumens per watt for most incandescent-filament lamps used in the home. (See Appendix C, Table C-1.) The higher efficiency of the fluorescent lamp often makes possible higher illumination levels for better seeing conditions. Other things being equal, there is no difference in visual effectiveness between incandescent-filament and fluorescent light; however, when the illumination level is low, fluorescent lighting may have a less pleasing psychological effect on some individuals than the same footcandle level of incandescent light. This appears to be particularly so if the fluorescent sources are one of the "cool" white types. Fluorescent lamps produce considerably less radiant heat than incandescent-filament lamps for a given illumination level and their life is four or more times as long, depending on operating conditions. The fluorescent lamp is ideal for providing a continuous line of light, and it is well adapted to modern architectural techniques in general. Incandescent-filament sources are used to produce concentrated beams of light. (See Appendix C.)

3.2 — ***Light Source Color*** — The color quality of the light may be a factor favorable to either source, depending upon individual preference. A room or an entire home can be lighted satisfactorily with either type of source, or the two can be combined successfully in the same room. As indicated in the footnote in Table II there are fluorescent lamps with about the same apparent color of light as that provided by filament lamps. Also, there are types which approximate daylight. Thus, if fluorescent lamps are to be used, and if the overall atmosphere of warmth associated with filament lamps is the objective, a warm white lamp should be selected to make colored surfaces appear much the same as they would under incandescent-filament light. If an atmosphere more nearly related to daylight is sought, a cool white fluorescent lamp should be used. In addition to the regular warm and cool white fluorescent lamps, there are also newer types, both warm and cool, which offer a greatly improved color rendition. This better color rendition is obtained with some loss in light output. The cool lamp of this new type often creates a fresher atmosphere. Both color-improved lamps bring out *all* of the colors in all fabrics, as well as in foods and complexions.

4. Lighting for Specific Visual Tasks

4.1 — ***Extent and Location of Visual Tasks*** — **(a)** The size and location of the areas to be lighted for most common home visual activities have been studied and reported in "The Functional Visual Activities in the Home."[11] For simplicity, each task is considered a plane, referred to as the illumination test plane, located both with respect to furniture or equipment grouping and to the eyes of the user. Representative furniture dimensions, typical of the most widely-used conventional home furnishings, and average heights of men and women when standing or seated are used. Sketches[11] give the associated dimensions for the selected tasks included in Sections 4.3 through 4.7. In the cases for which there are common lighting practices, the location of the luminaire with respect to the test plane and the shielding limits with respect to the eye are shown. Other dimensions for the test plane and associated conditions than those set forth here may frequently exist. Those used represent a high percentage of realistic home situations.

(b) The captions for each drawing include one typical lighting method, which can supply the recommended footcandles for that task. The attainment of the illumination levels given depends on (1) satisfactory lighting design of the luminaire (See Section 4.2); (2) recommended reflectances in the associated areas; (3) average room size and ceiling heights; (4) exact placement of the luminaire; and (5) good maintenance (Appendix E). The wattage of incandescent-filament or length of fluorescent lamp is given when the luminaire suggested is designed specifically for that size. When applicable luminaires, either fluorescent or incandescent, can vary from such exact specification, the minimum total lamp lumens are specified. Table C-1* lists the approximately lumen output of those lamps of both types which have common residence use.

4.2 — ***Lighting Methods*** — The methods of lighting the selected tasks or activities which are suggested in Sections 4.3 through 4.10 are not all-inclusive. It is recognized that specialized architectural and decorative treatments often require custom-developed lighting methods. The recommendations set forth here are practical, attainable, and suitable for the majority of homes. They include the use of permanently attached, built-in or portable luminaires. In most cases, although the luminaires are intended

*Commonly called "bulbs" or "tubes."

*See reprint.

Figure 3a. Examples of the blown-glass diffusing bowls originally developed to be used in portable lamps manufactured between 1934 and 1944 certified to meet I.E.S. specifications. Although the Society has withdrawn its participation in certification programs, bowls of this type are still manufactured. Used with a 100-watt lamp in an 8-inch, 150-watt or 50/150-watt in 9⅜-inch and 100/300-watt in the 10-inch sizes, the average brightness is about 1350 footlamberts.

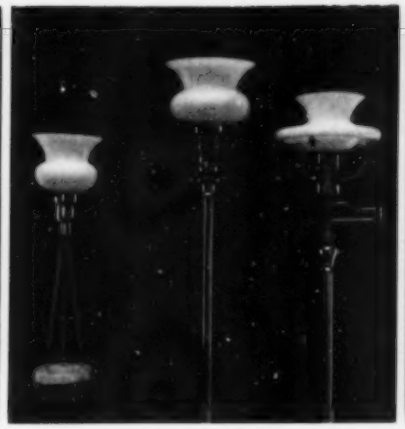


Figure 3b. Portable luminaires using diffusing glass bowls of these forms undergo rigid tests by an independent testing laboratory and bear a certification tag. The larger size is designed for the 100/300-watt lamp, the smaller for the 50/150-watt lamp. Some models with each bowl size are equipped with the circular fluorescent lamp. Average brightness of these bowls is approximately 2250 footlamberts.

Figure 4. The R-40 lamp used in a wide harp supplies levels of illumination equivalent to those from the smaller bowl in Fig. 3 with less refinement in lighting quality. It is not usually recommended for prolonged study or for tasks of high specularity, because of its relatively high average surface brightness — in the order of 4500 footlamberts viewed 45 degrees above vertical.

primarily for test-plane illumination, they also contribute to general lighting in the task surround. (See Section 5.1 (b).)

4.2.1—*Portable Luminaires*—**(a)** Portables are practical and effective for lighting visual tasks *only* if they coordinate technically good lighting design[12] with overall artistic design. Progress is evident in increased use of inner glass or plastic bowls which diffuse the light, increase light source size, and afford relief from heavy shadow and distracting reflections on glossy surfaces. Bowls with a variety of sizes, shapes and transmitting and reflecting qualities are available. *Tests have shown differences in illumination of as much as 80 per cent between 10-inch bowls of typical high and low densities used in the same luminaire.* Maximum diffusion and maximum transmission, consistent with recommended source-brightness, are desirable, Fig. 3a. Recent developments, Fig. 3b, provide somewhat higher amounts of downward light than do earlier types of bowls using the same wattage. The contour of these newer bowls provides control, within comfortable limits, of the brightness seen from standing positions. The bowl height with relation to socket position is designed to place the light-source center low within the shade for greater light spread. Some models include a circular fluorescent lamp for more light and flexibility of use.

(b) Fig. 4 shows an incandescent-filament lamp with special inner coating which has been developed in 50/150 and 150-watt sizes for use without a diffusing bowl. The area and coating of this lamp reduce the brightness much below that of the standard inside frosted lamps. However, when the density of the diffusing coating is light enough to provide the same illumination as the larger diffusing bowls using the same wattage lamp, the brightness is higher than that recommended for prolonged reading. Sixty- and 100-watt lamps in the A bulb and the 50/150-watt lamp in the PS bulb with the same coating (see Table C-I) offer the possibility of improved lighting from many existing portable luminaires.

(c) Three-light lamps with proper switch-control provide flexibility in fitting the light to the need.

(d) Shades for portable luminaires should have white or near-white linings. Strong color on the outer surface is not desirable except on opaque shades or ones of very low transmittance. When shades are viewed against low-brightness walls, they should be either very dense or opaque. For viewing against medium-brightness walls, shade brightness levels in the range of 75 to 125 footlamberts are recommended. With the exception of table luminaires for facial make-up, the brightness of shades of typical recommended sizes should not exceed 200 footlamberts. Open tops or light-transmitting covers are recommended for all shades. Slant-sided shades reflect slightly more light downward. More important factors in directing the light to the test plane are (1) proper positioning of the light center within the shade, (2) diameter of shade and (3) position of the lower edge of the shade with respect to the task. When the depth of shades for typical floor and table models exceeds 10 inches, the shade fitter must be sunk to maintain a vertical dimension of approximately 10 inches between the top of the bowl or harp and the bottom edge of the shade. Table III gives dimensions for portable luminaires of good lighting design. (See Figs. 48 and 58 and Section 5.1 (b).)

(e) Some of the beautiful portable luminaires of artistic and original design[13] on the market cannot be recommended for lighting serious visual

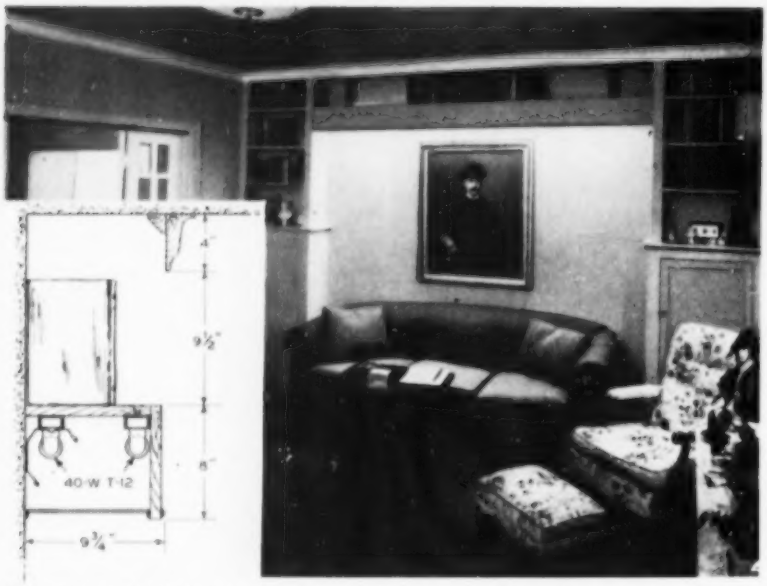


Figure 5. The shelf with its 8-inch front face which unifies the bookshelves forms a soffit for the natural inclusion of lighting for the davenport. Simple wood moldings hold the lightly-etched glass panel, shielding two parallel rows of two 40-watt warm white fluorescent lamps. To avoid high wall brightness and to increase illumination (average of 35 footcandles) on the reading plane (6½ feet to the glass) an asymmetric reflector was used on the back row. See inset cross-section drawing. In the front row, which lights the wall, the portrait, and those seated on the davenport, "deluxe" warm lamps were used without reflectors.

tasks, but they may be exceedingly effective in groupings where no critical eye work is carried on. In modern design, "functional" bullet-type reflector luminaires produce dark shadows and specular reflections, and are often difficult to place for good test-plane illumination without producing glare either for the user or other occupants of the room. However, they are useful for certain visual tasks when they can be located to provide complete shielding for the eyes, and when the task is small in area. The task should usually be matte finish, but in some workshop operations specular reflection aids seeing.

4.2.2—*Built-in Luminous Panels*—**(a)** A widely applicable method of supplying test-plane illumination is the relatively large luminous panel. Either diffuse or strongly directional lighting over extended areas can be obtained by this means. The panel conceals a "light box" recessed in ceiling, soffit or side wall. The most common wall application for vertical recessed panels is for lighting the face or figure at mirrors. (See Section 4.7.3.) The interior of the box should have a high reflectance. The shielding medium may be glass, plastic or louvers. Lens plates may be used for either spreading or concentrating the light. Louvers or lens plates are most often used in recreation or utility areas, although recent design developments of less commercial character have made them appropriate for other rooms. The panel or shield may be set away from the ceiling or wall a few inches allowing some light to escape around the opening. If the surfaces to be lighted by the panel are of high reflectances, they will (by reflected light) contribute materially to the brightness of the panel surround.

(b) ***High diffusion shielding materials destroy the directional control of the light.*** In addition, those that are flat in form create higher brightness at usual viewing angles than do low-diffusion, lightly etched, or configurated glasses. The latter, of course, are higher in brightness when viewed in line with the source, and should be avoided in vertical panel application and with incandescent-filament lamps. The degree of brightness uniformity of the cover plate is dependent upon its diffusing characteristics and upon lamp spacing. For uniform appearance of diffusing materials lamps are spaced no farther apart than 1½ times the distance between the lamp and the shielding medium. When end-to-end linear sources are employed, and when the width of the panel is more than 1½ times the distance between the lamps and the surface, parallel rows

TABLE III.—Dimensions of Well-Designed Portable Luminaires.*

Portable Luminaire Type	Height (Inches) to Bottom of Shade Above Floor	Minimum Shade Diameter Bottom (Inches)	Minimum Shade Diameter Top (Inches)
Large Floor	49	18½	10½
(with circular fluorescent)	49	18½	14
Junior Floor	47	16	9½
(with circular fluorescent)	47	16	14
Double Swing Arm	47	16	9½
(with circular fluorescent)	47	16	14
Bridge	48	13	8½
Table	40 (42" max.): (15-17" above 25" high table)	16	8½
Table	45 (15" above 30" high desk)	16	8½
Table (with circular fluorescent)	42	16	14
(with 300-watt bowl)	42 (17" above 25" high table)	17½	14
Wall (100-watt size)	Varies with application as noted.	10	6
(150-watt size)		13	8½
Dresser	19 (above dresser)	9½	7
Dressing Table	13 (above dressing table)	9½	7

*See Section 4.2.1 for characteristics of shade and under-shade features.

with this spacing must be added. Closer spacing is often necessary to incorporate sufficient lumens to provide the desired illumination on the test plane.[14] Either incandescent-filament or fluorescent lamps may be used. Where possible, fluorescent lamp length should approximate the length of the cavity. Where space is limited, fluorescent lamps can be placed as close as three inches to the panel, although better control of surface brightness is possible with a minimum distance of about six to eight inches. Individual switches for the rows or pairs of rows are recommended.

(c) Alcoves and soffits offer a natural location for the use of the luminous panel (Figs. 5 and 6). They provide locations for davenports, pianos, desks, beds, dressers and dressing tables, sewing centers, and utility work centers. The distance between the bottom edge of the soffit and the area to be lighted is generally between four and five feet. At these distances, two 4-foot rows of regular fluorescent lamps (approximately 600 lumens per foot), mounted eight inches above *slightly diffusing* glass or plastic will supply about 30 footcandles directly beneath. Polished metal reflectors directed toward the illumination test plane or light-control lenses would double this figure. In such an installation, a panel brightness of the order of 50 to 100 footlamberts, as viewed from nearby seated positions, is average for lightly etched glass. When there is no soffit, the light box may be recessed in the ceiling (practical maximum height about 8 feet 6 inches), but larger-area diffusing panels to accommodate more lamps (50 to 100 per cent more light) are essential for equivalent illumination.[14] For example, in an 8-foot 6-inch ceiling, a panel 18 inches by 6 feet of high-diffusion material (40 per cent initial transmittance and 54 per cent inner reflectance) with fluorescent lamps emitting about 7200 lumens provides in service about 20 footcandles for reading at the davenport beneath it. The lamps are centered 7½ inches above the panel, the brightness of which averages 300 footlamberts. This brightness is acceptable when the adjacent ceiling brightness (provided by other luminaires) is approximately one-twentieth as great. If additional lamps are added for higher illumination levels, the panel size should be increased to maintain a brightness for equivalent comfort.[15]

Figure 6. The above-cabinet furring extends 13 inches out from the face of the kitchen cabinets to provide space for two rows of fluorescent lamps above the work surfaces. Diffusing glass is used. Average footcandles on work surfaces, 70, and on 30-inch plane at room center, 35; total lamp watts, 488.

4.2.3—*Recessed Downlights*—**(a)** Footcandle levels over a wide range are readily delivered to work areas by recessed incandescent-filament lamp downlights. The small area, concentrated distribution, and high source brightness of downlights combine to produce harsh shadows and conspicuous reflections from specular surfaces. Their use for tasks of specular character thus requires exact placement of the unit with respect to task and eye position, so that the angle of the incident light is such that reflections of the source are not toward the eyes, Fig. 7. Even so, there is often unavoidable glare if the visual task is not in a perfectly flat plane. Since downlight distribution is limited, careful attention must be given to general lighting to maintain the recommended brightness ratios between task and surroundings. Light output and distribution vary greatly among the many types available. It is thus important to examine candlepower distribution curves in selecting units for lighting specific visual tasks. Types using standard inside frosted lamps usually cannot, without excessive brightness, provide recommended task illumination levels of 20 footcandles or higher without the use of a lens, reflector, prismatic glass, or combinations of these, Fig. 8. Boxes without light-control devices are best applied in circulation areas where high brightness is less objectionable; glass area should not be less than about 50 square inches for the 60-watt lamp — proportionate-

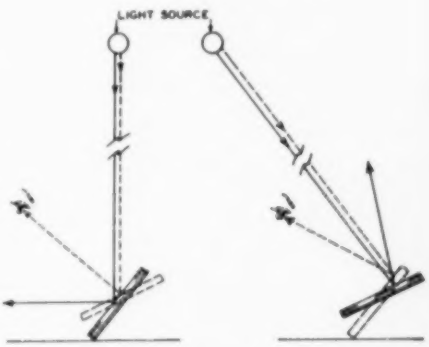


Figure 7. Specular (glossy) reflection is controlled by light source and task positions as illustrated in these sketches. The solid lines indicate positions of light source and task which avoid specular reflection toward the eye. Higher illumination on the task is provided when the light source is placed directly over the task as shown at left.

Figure 8. Ten-inch-square prismatic plates, 5 feet 4 inches above pool table, conceal horizontally placed 150-watt lamps in the three downlights spaced for nearly uniform illumination, 40 footcandles. Luminous wall urns (Section 5.2.3 b) used against light walls provide background lighting. Under these conditions, a 40-watt lamp may be used in each socket without glare; venetian blinds lighted from incandescent lamps located in outside areaway.

Figure 9. Centered 70 inches above the reading plane, this downlight with a louvered flood-type R-40 150-watt lamp provides 20 footcandles (50 with a PAR-38 flood). If reading matter is held at the normal 45-degree angle, no reflected glare reaches the eyes from shiny surfaces. However, most magazines cannot be held perfectly flat, and some source reflections are usually present. Additional light from the nearby lighted cove and cornice as well as high reflectance surrounds improve comfort. (Section 5.2.3.3.)

ly larger with increased lumens. See Figs. 40 and 51.

(b) Recessed boxes with the lamp in horizontal position require a minimum vertical space of 4½ inches above the ceiling. For vertical positioning of a standard lamp and for projector and reflector lamps, a minimum of 7 inches to 8½ inches is required. An exception is a luminaire using a special reflector with a silvered-bowl lamp, its bowl protruding beneath the ceiling. Equipment with greater depth requirements is common.

(c) Projector and reflector lamps have downlight application and require ceiling apertures no greater than three to five inches (Fig. 9). Shielding to 45 degrees below the horizontal is readily attained by baffles or louvers, painted a matte finish black or dark gray. (Any color with a reflectance not exceeding about 15 per cent may be used.) Very lightly etched glass may cover the aperture, but for acceptable brightness the lamp must be equipped with louvers unless it is five inches above the ceiling line. When the lamp is in this position and no cover glass is used, horizontal baffles inside the unit reduce the brightness of its interior. In any case, boxes using projector or reflector lamps should be black-finished inside. Since the major light output of downlights using these lamps is generally limited to small angles (10 to 20 degrees) the area to be lighted and its distance from the light source determine the number of units required to provide uniform illumination over the task plane.

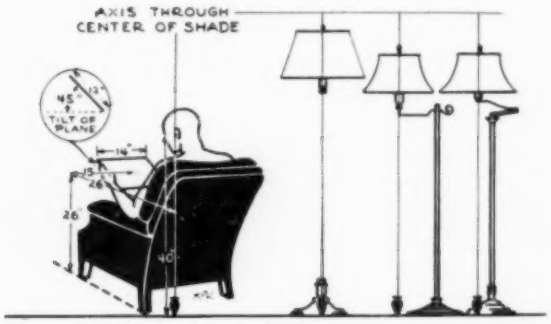
(d) When smaller ceiling openings, one to two inches or exact control of the light beam are desired, pin-hole type spot units are used. These usually require greater recessing space above the ceiling, often include an optical system and are used most frequently (Fig. 45) for effect lighting.

4.3 — *Reading* — The specular quality (glossiness) of printers' inks and many papers used in magazines and books[12,35] may cause glaring light source reflections which reduce print visibility (See Sect. 2.1.3 b). These are minimized by the use of carefully placed diffuse sources. Brightness of the lamp or diffusing medium should not exceed 3000 footlamberts for 40-footcandle levels, (2250 footlamberts for 30 footcandles)[26] and lower source brightness is desirable. At least 15 per cent of the illumination on the test plane should be derived from other than direct light from the luminaire. Luminaire placement, with respect to task and eyes is critical. On it depends: (1) the minimizing of annoying source reflections, (2) even distribution of light on the task, and (3) avoidance of direct light in the eyes of the person performing the task.

4.3.1 — *Seated Position in Lounge Chairs and Divans* — Floor and table luminaires are most commonly used. Types described in Table III and in Section 4.2.1 currently provide the best results, provided they are correctly placed and lamped as set forth in Fig. 10. In the case of table luminaires, it is to be noted that the lower edge of the luminaire shade should not be materially above or below eye height. With lower- or higher-seated furniture, table or luminaire heights may be adjusted to maintain this relationship between the eyes and the bottom

edge of the shade. Linear wall elements, Fig. 12, or large-area recessed lighting in canopies, ceiling, or furred-down soffits may be designed for any illumination level. Small-area downlights are less desirable because of high source brightness.

4.3.2—*Seated Position in Bed*[16]—Wall hung luminaires of either portable or permanent types provide illumination more efficiently and over a wider bed area than do bedside table luminaires, Figs. 13, 14, and 15. Thus greater freedom in the position of the reader is possible. Complete shielding of the wall-hung light source at 45 degrees above the horizontal is recommended. Unless the mattress top materially exceeds a 22-inch height, a 25-degree shielding below the horizontal is sufficient in fluorescent luminaires and is assumed in the data on test-plane illumination, Fig. 13a. In the case of double beds, two bedside or incandescent wall luminaires are required, or a linear wall luminaire which approximates the bed width (See Fig. 49).



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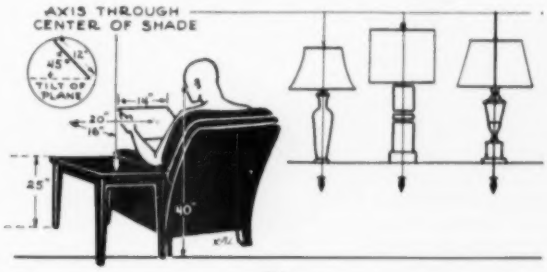
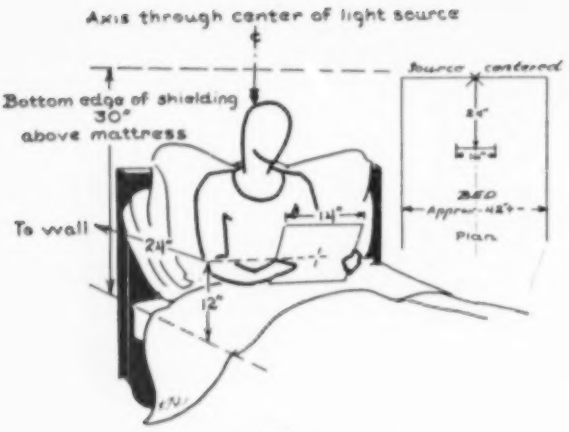


(b)

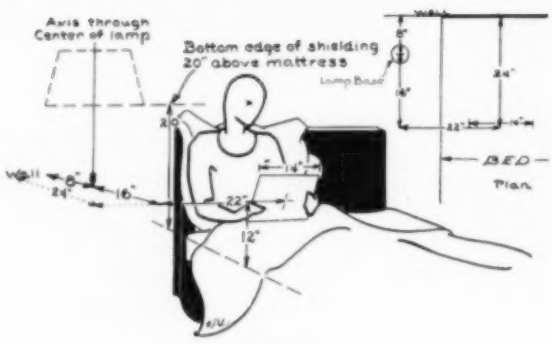
Figure 10. Normal seated positions in average upholstered furniture place the eyes of the reader at 40 inches, and the center of the 14-inch wide and 12-inch high test plane (tilted 45 degrees toward the reader) at 26 inches above the floor. For portable luminaire application, the vertical axis through the center of the shade (not necessarily through the luminaire shaft) establishes its location—(a) 26 inches back from a point 15 inches to left or right of the plane center for floor or wall-hung types, (b) 16 inches back from a point 20 inches out for table types. With the recommended incandescent portable luminaires (Sections 4.2.1 and 4.3) 300 watts are minimum for 40 footcandles 150 watts for 20 footcandles (increases of 40 and 75 per cent respectively; may be obtained by addition of 12-inch circular fluorescent lamp). See Fig. 11.

Figure 11. This custom-built double swing arm luminaire is indicative of new trends in table and floor models using only circular fluorescent lamps. This light source in well-designed equipment produces high luminaire efficiency, so that a single 1600-lumen circular lamp can provide illumination comparable to bowl types using a 150-watt incandescent lamp. Two nested 8- and 12-inch lamps approximate 300-watt incandescent types.[12] Shades may be as shallow as 5 inches, but need top enclosure with translucent material.

Figure 12. Mounted at the center of the under side of this built-on bookcase, a 48-inch fluorescent lamp (2400 lumens) provides 20 footcandles for reading at the sofa.[7] A polished reflector increases this value to 35. Shielding from all viewing angles is afforded by the wood face, the lower edge of which is 48 inches above the floor. Note the right angle cove formed at the top of the shelves.



(a)

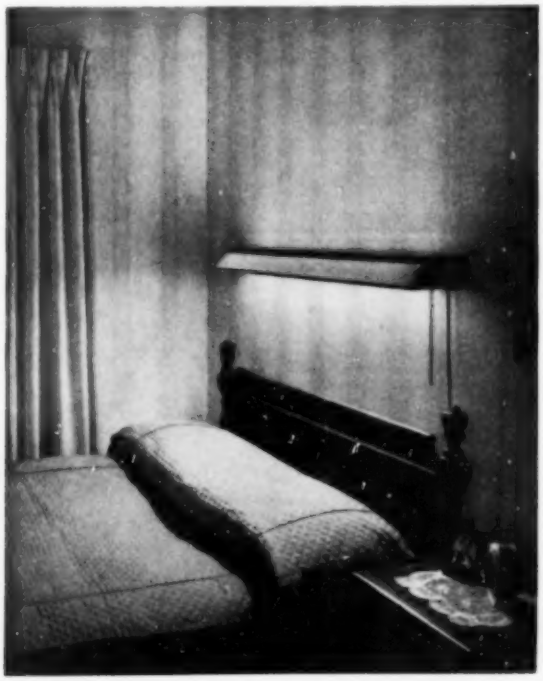


(b)

Figure 13. Variation in bed heights requires the positioning of the reading plane and luminaire with respect to the top of the mattress. Recommended posture locates eyes at 20 inches above mattress and allows desirable 45-degree tilt of reading matter. With wall-mounted luminaires (a) of either incandescent or fluorescent types, the lower edge of the shielding is 30 inches above the mattress; 40 footcandles from a minimum of 2000 lamp lumens or 25 footcandles from a minimum of 1400 lumens. See Figs. 14 and 15 for detailed examples. With table luminaires (b) of the recommended types, the lamp axis can be no more than 22 inches to the left or right of the plane center and 16 inches back, with lower edge of the shade at eye level, 40 footcandles from a 300-watt incandescent lamp or 20 footcandles from a 150-watt lamp. (Sections 4.1, 4.2.1 and 4.3.2.)

Figure 14. The 13-inch silk shade covers a certified bowl (Fig. 3) with a 50/150-watt lamp for about 60 footcandles on book when reader sits beneath the luminaire, 40 footcandles at either side. Types for the R-40 lamp (Fig. 4) approach these levels. Somewhat smaller luminaires equipped with a 6-inch diffusing bowl and a 100-watt lamp give 20 footcandles when lamp burns base down, and about 50 per cent more when base up. In all cases, lower edge of shade is 30 inches above mattress top.

Figure 15. Upper shielding of the 48-inch fluorescent lamp is provided by louvers in this luminaire. The shallow curved front shielding acts in part as a reflector and increases the illumination on the reading plane to nearly 60 footcandles — about 50 per cent more than from the same lamp with a vertical opaque shield. Lower edge of luminaire is 30 inches above mattress. A wall outlet would eliminate exposed cord.



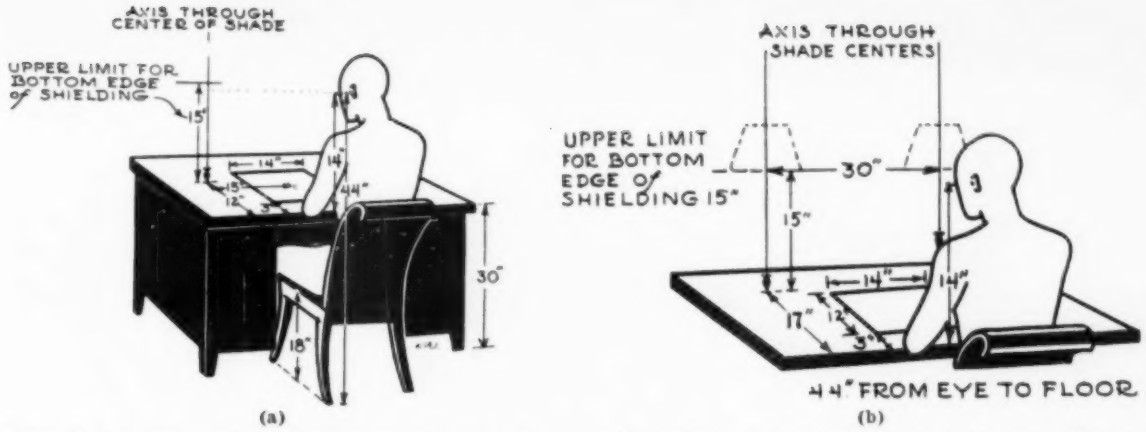


Figure 16. The horizontal test plane is located three inches back from the front edge of the desk. The selected eye height is 14 inches above desk top, average for good adult posture and readily attained by seat pads for small-statured persons. Lower eye position places eyes too close to work and subjects them to the discomfort of viewing the high brightness of the lower inside of shades. The indicated upper shielding limit, 15 inches above desk top, is the practical lower limit for best lighting distribution. With a single table luminaire (a), placement is 15 inches to the left for righthanded persons, to the right for the lefthanded, and no more than 12 inches back from the front edge of the desk. For 40 footcandles, 150-watt incandescent; for 25 footcandles, 100-watt. With two wall-hung luminaires (b), the lamp axes should be 30 inches apart and no more than 17 inches back from the desk front. For 40 footcandles, 100-watt incandescent each; for 20 footcandles, 60-watt incandescent each. (Sections 4.1, 4.2.2 and 4.3.3.)

Built-in lighting elements (Section 4.3.1) are applicable if properly designed for test-plane and eye position. Floor-based luminaires placed as in Fig. 13b (300-watt for 40 footcandles) may be used for hospital beds because the mattress is higher than on other beds and raises away from the head of the bed for a seated position.

4.3.3—*Seated on Straight Chairs at Desks*—Concentrated study[17] at a desk deserves greater attention to visual environmental conditions than do writing, drawing, or casual reading. Visual comfort, good posture, and mental attentiveness are fostered by brightness ratios in the visual field in the order of 3 to 1, which may be attained in several ways. Desk tops should be non-glossy and light in color (35 to 50 per cent reflectance) or large pastel blotters should be used. Desks can be placed flat against a wall but never in front of a window. If the wall is dark or strongly patterned, a framed tack board (50 per cent reflectance) about 42 inches wide and 36 inches high may be hung above the desk. Study-type desk luminaires should allow generous upward light; they should use dense but light-colored shades (10 to 80 footlamberts), and should incorporate a source of light (lamp and diffuser) not exceeding 2250 footlamberts, preferably much lower. They should be carefully placed as in Fig. 16. Two luminaires provide more useful light over the entire desk top than a single one unless it is a linear luminaire above and parallel with the desk. When a light source is centered ahead of the eyes, and the angle of incidence is greater than 50 degrees, specular (glossy) reflection is unavoidable.[12] Typical fluorescent desk luminaires placed in front of the user, with the incident light less than 50 degrees, generally do not provide sufficiently even test-plane illumination. If the fluorescent lamp, shielded at eye level as in Fig. 17, is placed over the approximate center of the plane, the

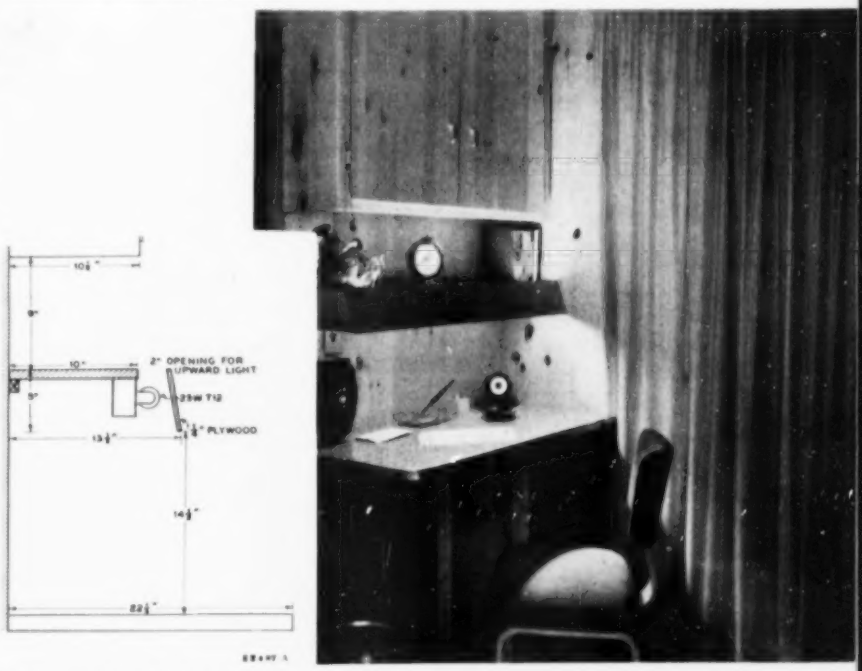


Figure 17. Built-in desk top is 22½ x 40 inches, covered with light green linoleum. A 33-inch fluorescent lamp located as shown in the cross section provides 50 footcandles with little variation over the desk top.

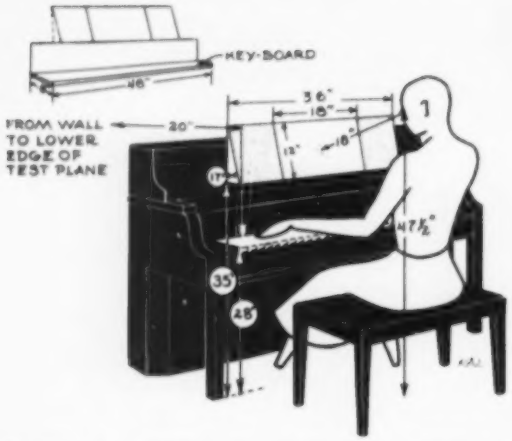


Figure 18. In addition to the primary test plane, 12 inches high and 18 inches wide, two secondary planes, to the right and left of it, and the keyboard are significant. The average illumination on the secondary planes should not vary from that of the primary plane by more than five to one. The lower edge of the music rack planes is 35 inches above the floor, and they are tilted back from the viewer 17 degrees. On an 8-foot 6-inch ceiling, a typical luminaire for a 150-watt reflector or projector flood lamp placed 24 inches in front of the music rack center and tilted 35 degrees above the vertical provides about 40 or 100 footcandles respectively. (Sections 4.1 and 4.3.4.)

Figure 19. In the arched niche designed for piano placement, two 40-watt fluorescent lamps, mounted on the 8-foot flat white ceiling near the opening side, provide almost 40 footcandles.

area and position of the specular reflection is least bothersome, and it can be completely avoided by moving the task a few inches back or tilting it a few degrees.

4.3.4—*Reading Piano Music — Seated on Piano Bench* — Because of the nearly vertical test-plate position, Fig. 18, it is difficult to obtain satisfactory illumination with conventional portable luminaires. There is marked decrease in light from one side of the sheet music to the other when a single luminaire is used. Normal location of table-based types, unless they have extension arms, places the light source behind the test planes. A floor luminaire (of certified type) with a 300-watt incandescent lamp and a circular fluorescent lamp will provide 40 footcandles on the primary test plane when the shade axis is 20 inches to the left or right of the keyboard center and 18 inches in front of the music rack base. This is an awkward position for the player, and a pair of double swing-arm floor luminaires serve better. Bowl types designed for 150- or 300-watt incandescent lamps, with shade axes 22 inches to side of keyboard center and 13 inches in front of rack, provide about 30 to 50 footcandles respectively with good uniformity on all test planes. Shades must be translucent (at least 100 footlamberts). Most currently manufactured rack-attached luminaires place the lamp too close to the music score, with sharp variation in score brightness. The lamp should be at least 6½ inches out from the top or bottom of the test plane. Further design development in portable luminaires is needed.[18] When advance planning is possible, permanent ceiling-affixed or recessed lighting is recommended. Large-area sources (Fig. 19) apply as do downlights, which are easily placed for avoidance of specular reflection toward the eyes.

4.4 — *Sewing* — The small detail and low contrast between thread and material usually involved in sewing make it a visually difficult task. Tests and observations[19] show that high source brightness is less objectionable than it is for reading, and that specular reflection seldom causes difficulty. Light with some directional component is usually more satisfactory than highly diffuse light alone.

4.4.1—*Hand Sewing*—The test plane location is shown in Fig. 20. (For casual sewing conventional portable luminaires may be placed as shown in Fig. 10 — at left for right-handed persons). To obtain higher illumination, 80-150 footcandles, floor types may be placed with the lamp axis 15 inches to the side of the test-plane center, and 12 inches back; table luminaires, 15 inches to the side and 6 inches back. These locations place the shade very close to the user and are not advisable beyond the period of concentrated sewing. Even when so placed, only one present type (that which combines a 300-watt incandescent lamp with circular fluorescent) provides 100 footcandles. The higher illumination levels needed for difficult or prolonged sewing may be attained by means of auxiliary equipment such as clamp-on devices (Fig. 21) or shielded flexible-arm luminaires using standard 60- to 100-watt lamps or the 75-watt R-30 spot or flood lamp. A variety of direct-lighting portable luminaires, both incandescent and fluorescent, not included in Table III, are applicable for sewing.

4.4.2—*Machine Sewing*—Most modern sewing machines are equipped with low-wattage lamps which produce on an average 35 footcandles in front of the needle. With the usual machine lamp, there is shadow and uneven light over the primary test plane, and practically no light from it reaches the secondary plane, Fig. 22. Auxiliary lighting is essential. A higher degree of diffusion than for hand sewing is

desirable to avoid shadows cast by the machine parts. A wide choice of floor or wall luminaires, placed slightly to the left of the operator or needle, can produce from 40 to over 150 footcandles[20] with nearly equal levels over the secondary plane. See Fig. 23. Where machines have a fixed location and frequent use, inbuilt lighting overhead is desirable, Figs. 24 and 57.

4.5 — *Food Preparation* — Modern kitchen planning generally locates the work centers along walls. A central ceiling luminaire cannot provide recommended illumination for these areas, since its light is intercepted by the worker.[21] Thus, local lighting must be provided for the important work centers. The strong directional character of some local lighting often creates shadows, but they are seldom objectionable for the kind of tasks performed. In some farm and large kitchens, work tables are placed in the center of the room. Here the required

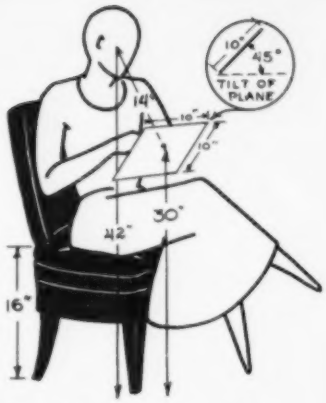


Figure 20. The more erect position assumed for sewing than for reading locates the eyes of the average woman at 42 inches above the floor. A 10-inch square test plane, tilted 45 degrees toward the eyes, is selected. Portable luminaires of wide variety have good application as described in 4.4.1 or ceiling- or wall-mounted downlights can be selected and placed for any illumination level.

Figure 21. The clamp holder, attached to the standard of the bridge lamp (150-watt in 8-inch diffusing bowl), supports shield with R-30 floodlamp. The combination provides comfortably 150 footcandles for fine sewing on dark material.

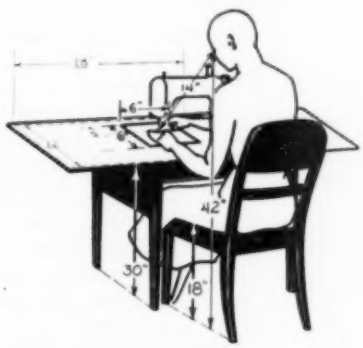


Figure 22. (left) The test plane is 6 inches square, located so that the needle point is 2 inches forward from the center of the back edge. A secondary plane, requiring at least 1/10 the primary plane illumination, measures 12 x 18 inches, with the needle point centered on the 12-inch dimension and 6 inches in from the righthand edge. Luminaires must shield the eyes at 42 inches above floor, Fig. 23. (See 4.1 and 4.4.2.)

Figure 23. (below left) A pin-to-wall lamp, with R-40 150-watt white indirect lamp and 11-inch white lined shade produces an average of 100 footcandles at the needle point and across the extension shelf, with lamp centered 7 inches to the left of and 4½ inches behind the needle. Additional light is provided by the small shielded lamp on the front of the machine and by a 2-lamp (40-watt fluo- recessed) ceiling luminaire.

Figure 24. (below right) This built-in sewing center has its "fixed" lighting (100 footcandles average on primary and secondary planes) from the semi-flush adjustable (10-degree tilt) PAR-38 floodlamp located in the 8-foot ceiling, 13 inches in front and 7 inches to the left of the needle. High-reflectance surfaces and general lighting from a ceiling luminaire maintain low brightness ratios. A PAR-38 spot can provide 350 footcandles for work on dark material.

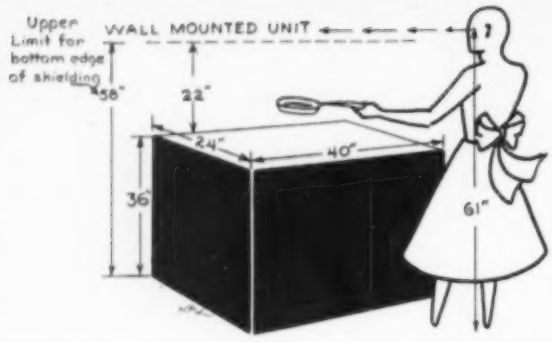


Figure 25. The entire area of sink and range tops becomes the plane to be illuminated, 24 inches from front to back and 40 inches wide. It is 36 inches above the floor. Not shown, but of equal importance, is the counter area plane, 20 inches x 24 inches. Wall luminaires must shield the eyes with lower edge of dense or opaque shielding no more than 22 or less than 18 inches above test plane. Upward light is desirable if there are no cabinets above; with cabinets, lamps may be mounted directly beneath, on the wall, or at the front edge for best distribution, if carefully shielded from direct view. For 40 footcandles a 33-inch fluorescent lamp is minimum for sink or range and a 24-inch lamp for every 30 inches of counter length. For ceiling luminaires over range or sink, mount them no more than 5 feet above the work surface; they should be shielded to at least 30 degrees below the horizontal; minimum fluorescent lamp lumens 4200, in lengths of 33 inches or more; or 150-watt PAR 38 flood. See 4.5.1.

Figure 26. A white plastered cavity, 11 x 11 x 50 inches, is formed in the sink soffit (lower edge 7 feet 6 inches above floor) for two 48-inch, 2400-lumen fluorescent lamps with reflectors (average 60 footcandles). A configurated glass panel is used. A 20-watt bracket, white enamel reflector, provides counter lighting.

illumination may be obtained from an efficient semi-direct fluorescent central-ceiling luminaire mounted at normal ceiling heights, such as illustrated in Fig. D-2, Appendix D.* The use of sufficient numbers of luminaires of either ceiling-attached or recessed types for either incandescent or fluorescent sources can supply both localized and general lighting.[14] See Fig. 6.

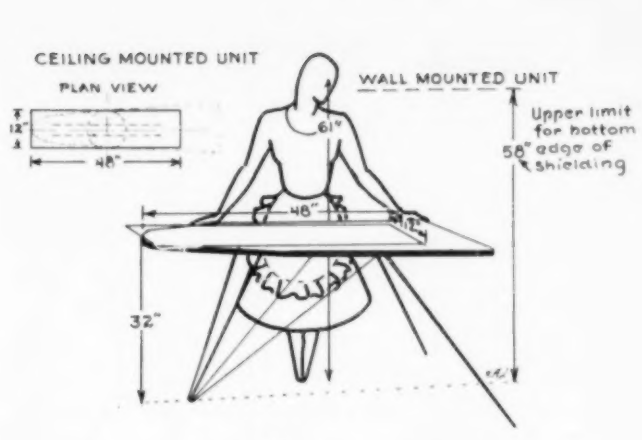
4.5.1—*At Sink, Range, or Counter—Standing Position*—Many of the operations in food preparation and clean-up involve accurate and quick seeing of small and low-contrast detail. In addition the work areas are large (Fig. 25), and their illumination demands appropriately-designed permanent luminaires. Although modern ranges incorporate lighting devices, these are seldom mounted sufficiently high to provide light inside deep utensils or even over the entire range surface. When the work centers are against walls, they are more practically lighted by linear, wall-attached luminaires. Counter tops should avoid glossy finish and have a reflectance of 35 per cent or more. The width of the range and sink surfaces is such that two incandescent luminaires (lower edge of shielding at 58 inches—60-watt each, spaced 20 inches apart) are required to obtain the recommended illumination level. When the sink or other work area is located in front of a window and is flanked by wall cabinets, bare lamps may be installed on the surface of the ceiling or furring strip, provided they are shielded (minimum depth eight inches). The wiring outlet or outlets should be four inches back from the shield. The lamps, which may be incandescent or fluorescent, may also be recessed in the soffit, Fig. 26.

4.6—***Laundry—Washing and Ironing***—For double laundry tubs, the illumination plane, 20 by 48 inches, is located in the same position with respect to floor and eyes as the ironing board, Fig. 27a, and may be similarly lighted. Shielding of the lamps 30 degrees below the horizontal is desirable. When industrial-type luminaires, Fig. 28, are not suitable, better appearance is attained from recessed or close-to ceiling semi-direct luminaires. However, their greater distance from the task and their lower efficiencies must be compensated for by increased lumens.

4.7—***Grooming***—Several visual problems are involved in the processes of grooming, many of which require the use of a mirror. Lighting equipment at a mirror should direct light *toward the person*, and not on the mirror. Because the apparent distance of the face or figure as viewed in a mirror is twice its actual distance from the mirror,[22] and because the details that must be seen in shaving and critical inspection of dress or make-up are usually small and of low contrast with their background, the visual task may be a severe one. Minute details are not visible from the selected illumination test-plane position, chosen for average viewing conditions (Appendix A*). For some phases of facial care, hand mirrors, even of magnifying types, must be used, and the face must be brought close to the light source for higher light levels. The brightness of surfaces reflected in the mirror and seen adjacent to the face-reflection should not be in distracting contrast with it.

4.7.1—*At Bathroom Mirrors*—Three luminaires are essential to illuminate the three test planes, Fig. 29: (a) one at each side of the mirror to illuminate the vertical planes of the face and below the chin, and (b) one immediately overhead to light the top of the face and head. The wall luminaires (a), spaced 30 inches apart, must be higher

*See reprint.



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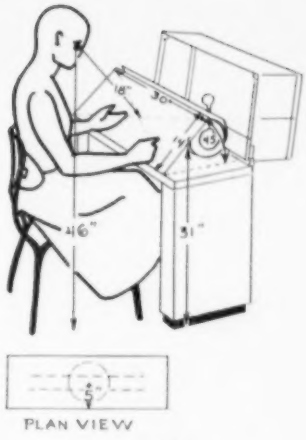


(b)

Figure 27. For hand-ironing in a standing position (a), the selected 12 x 48-inch illumination plane is 32 inches above the floor. When ironing board is close to parallel wall, a 48-inch fluorescent wall luminaire applies, if lower edge of shielding is at 58 inches above floor. Or industrial-type ceiling luminaires seen in Fig. 28, no more than 7 feet above floor, provide 40 footcandles with two 33-inch fluorescent or one 150-watt silvered-bowl lamp. For machine ironing (b), the tilted position of the 14 x 30-inch plane requires placement of machine so that the center of the luminaire is 5 inches back from the front edge of the plane. See 4.6.

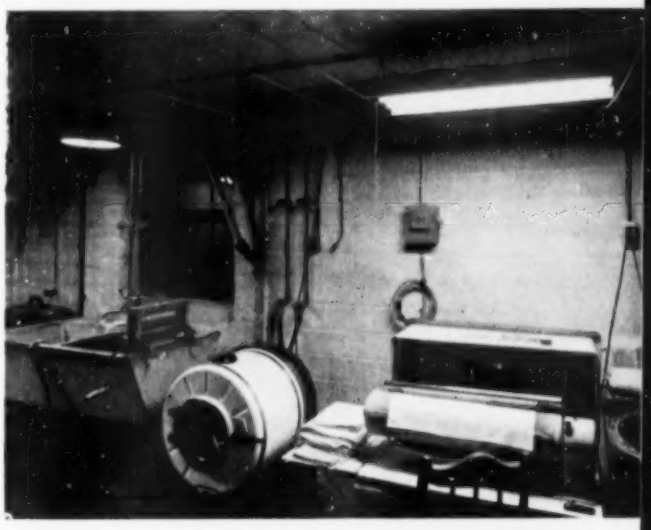


Figure 28. (right) Direct-lighting reflectors of these industrial types for both incandescent-filament and fluorescent lamps are suitable for basement laundries or utility rooms where decorative treatment is not essential. See 4.6.

Figure 29. (below) Two 6 x 8⅝-inch right-angle planes, which converge at a point 16 inches out from the mirror, are centered vertically 61 inches above the floor. They represent the front and both sides of the face. A third plane, 12 inches square, its front edge also 16 inches out from the mirror, is tilted up 25 degrees above the horizontal and represents the top of the head. Shielded vertical brackets (minimum 700 lumens each) centered at 60 inches above floor and 30 inches apart, combined with a ceiling luminaire (minimum 1300 lumens) mounted 12 to 18 inches out from wall, supply 40 footcandles on the three planes. For fluorescent sources, deluxe lamps are recommended.

Figure 30. (below right) A slanted ceiling necessitates the use of three brackets for both shaving and general room illumination. Since the room area is only 40 square feet, the result is satisfactory. An unusually low brightness ratio exists between the luminaire and the pale yellow wall. With two 40-watt incandescent each, the glass brightness averages about 600 footlamberts; with about 50 footcandles on test planes. See 4.7.1.

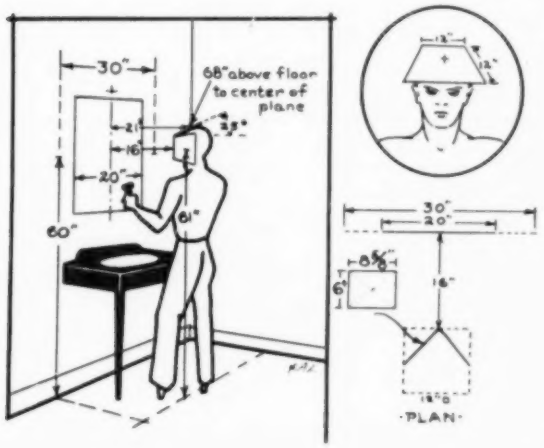


Figure 31. Three two-lamp units are butted together and recessed in the 8 x 8-inch furred down section along the 12-foot 9-inch mirrored wall. The built-in lavatory and drawers are topped by a continuous 65 per cent reflectance vanity shelf. Ribbed glass panels, 180 footlamberts at viewing angles 2 feet out from the vanitory edge, shield 40-watt deluxe cool lamps; 40 footcandles on the face when standing 4 inches ahead of the cabinets.

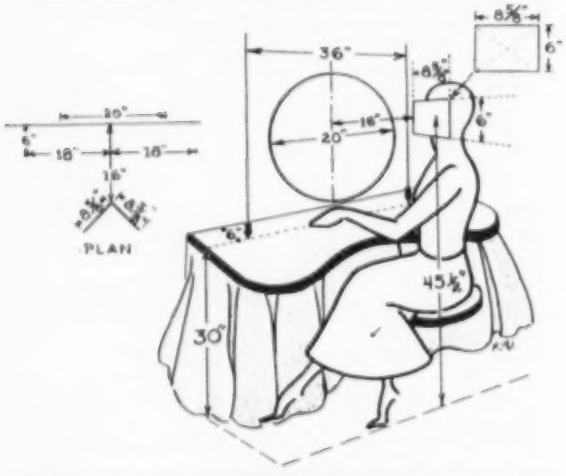


Figure 32. A recessed vapor-proof unit (minimum 60-watt incandescent) is recommended over shower and tub stalls. When toilet is enclosed, a small semi-direct luminaire or recessed downlight (minimum 60-watt) is needed. Here, recessed 75-watt R-30 floodlamps supply nearly 20 footcandles.

Figure 33. (left) For facial make-up at dressing tables or dressers the two illumination planes are the same as the vertical pair for the bathroom mirror, but located at the average woman's cheek height. Table or wall luminaires, *without inner diffusing bowls* but with near-white shades, are centered 6 inches out from wall and 36 inches apart. Center of shades is in line with test plane center, 45½ inches above floor for seated position at dressing tables, 58½ for standing position at dressers. For 20 to 25 footcandles, 100-watt white or 30/100-watt incandescent-filament. See 4.7.2.

Figure 34. (left) The papered wood frame canopy, the length and width of the dressing table, contains four 42-inch (25-watt each) deluxe warm fluorescent lamps; 35 footcandles on cheeks, 100 on top of head. Lightly-etched glass panels are used above and below lamps. Shadows from direct light, although normally soft from such a large source, are further reduced by light reflected back from etched mirror table top (40 footlamberts), curved in at center to place figure beneath canopy for more light on top of head. (For photograph a black cloth was placed to obscure room reflections in mirror. See 4.7.)

in brightness for the required illumination than generally desired but should not materially exceed 1000 footlamberts. Adjacent walls must then have a 50 per cent or higher reflectance to avoid visual discomfort. When lack of wall space forces a decrease in the recommended 30-inch spacing[23] between the wall luminaires, a lower brightness in the order of 800 footlamberts becomes essential because the light sources are nearer the direct line of view. The overhead ceiling luminaire (b) is centered over the front edge of the wash bowl and serves as stated for test-plane illumination and for general lighting of rooms under approximately 60 square feet. In larger bathrooms, a ceiling luminaire installed in the center of the room is desirable. In this case, the preferred mounting of the over-mirror luminaire may be on the wall above the mirror rather than on the ceiling, Fig. 30. When a wide mirror extends over the wash bowl and a vanity shelf, use a single, shielded, overhead fluorescent luminaire with two rows of lamps approximately as long as the mirror in width. Shelf and bowl surfaces should be of medium to high reflectance, Fig. 31. When tub, shower, or toilet is enclosed, each requires additional lighting, Fig. 32.

4.7.2—*At Dressing Tables and Dressers*—Portable vanity luminaires must have sufficient height (Table III) to locate the shade center in line with the center of the cheek, Fig. 33. With typical shade sizes (7 inches deep, 7-inch top and 9½-inch bottom diameters), the shade brightness will be about 500 footlamberts if the recommended face illumination is attained. The use of a three-light lamp allows lower brightness for more comfortable viewing from other positions in the room, once make-up is completed. Where portable luminaires are not suitable, Fig. 34, and especially for built-in tables, large-area luminous panels set in soffit, canopy, or ceiling apply. Or when the mirror is no wider than about 40 inches, vertical side panels (4.2.2) may be designed for the recommended illumination.

4.7.3—*At Full-Length Mirrors*—**(a)** A pair of long narrow luminaires installed on each side of a full-length mirror are the most practical and efficient means of providing the recommended illumination over the test plane, Fig. 35. For the detection of very small details such as lint, soil, spots, etc., where the contrast with the background is frequently low, one must stand closer to the mirror than the selected test-plane position. Higher footcandles than recommended for the test plane will be obtained up to about 16 inches from the mirror in installations such as shown in Fig. 36. Conversely, for quite casual overall appraisal, or when attention is directed to the lower portion of the figure, one may require a greater distance from the mirror. The visual requirements are usually less exacting, and lower illumination levels satisfactory for the purpose are obtainable at distances up to five feet.

(b) Side wall luminaires may be surface-mounted or recessed in the wall (4.2.2 a); the latter are more satisfactory when they are tilted 30 to 45 degrees toward the viewer. Because the luminaires are nearer the direct line of sight than in the case of typical bathroom shaving mirrors, the brightness of luminous surfaces should not exceed 800 footlamberts, Fig. 36. When mirror-side luminaires are not feasible, a wall luminaire may be designed with light distribution predominantly toward the figure for mounting at the top of the mirror.

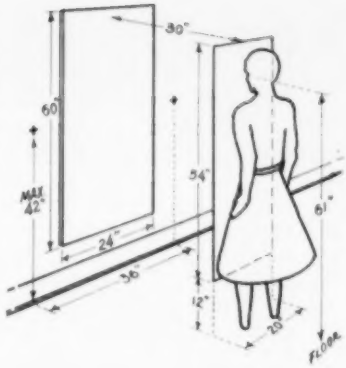


Figure 35. There is wide variation in the distance from a full-length mirror that persons stand for figure and grooming inspection. A distance of 30 inches is selected as reasonably representative for the position of the illumination test plane, 20 inches wide and 54 inches high with its lower edge 12 inches above the floor, centered on and parallel with the mirror. For critical inspection, 40 footcandles is attained by wall luminaires, approximating test plane height, minimum 1850 lumens each, centered no more than 42 inches above floor or less than 18 inches to each side of mirror center. For casual appraisals, similarly-located luminaires, 24 to 36 inches in vertical height, minimum 1000 lumens, supply 20 footcandles with acceptable distribution over the test plane. See 4.7.3.

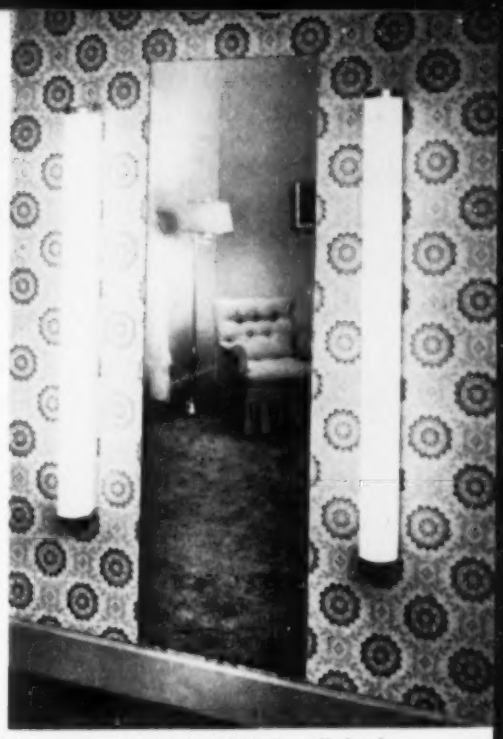


Figure 36. A plastic-shielded wall luminaire equipped with one 40-watt (1850 lumens) fluorescent lamp mounted on each side of the wall mirror provides 40 footcandles for critical viewing of the costume at test plane position (Fig. 35). The luminaires are centered 36 inches above the floor and 36 inches apart.[9] Brightness of the luminous surface is about 600 footlamberts.

4.8—***Hobbies***—The variety of recreational activity which involves critical seeing is too great for discussion here. For hobbies that are seriously and frequently followed, permanent lighting should be planned in terms of the visual character of the activity (2.1 and Appendix A). When the activity is occasional, easily adjustable and easily stored portable luminaires are more practical. There are, for example, a variety of adjustable devices of directional character designed for either fluorescent or incandescent lamps. They may be table or floor-based, or for wall mounting. Thus, highly diffuse or sharp directional lighting, or a combination of both, may be readily applied.

4.8.1—*Home Carpentry*—The area of activity at a typical workbench, 36 inches high, is assumed to be 20 inches wide and 48 inches long in line with

Figure 37. Flexible and efficient lighting is simply rigged up with portable deep reflector, 150-watt inside white bowl lamp 55 footcandles; hung by eyelet on ceiling-attached wire, it is easily moved to work location. R-40 spot lamp is positioned to supply at drill press over 400 footcandles; 30 per cent reflectance walls control wall brightness.

Figure 38. The 8-foot fluorescent luminaire (two 96-inch T-12 4900-lumen lamps) supplies an average of 50 footcandles on the table top. Louvers provide recommended lengthwise shielding, and glass panels the side shielding. When viewed lengthwise from 3 feet back of table edge, the highest brightness is 300 footlamberts. The 8-inch deep cornice is one foot out from wall; wall brightness is 40 footlamberts near cornice and about 10 footlamberts at standing eye level. See 4.8.2b.

the front edge of the bench. With a reflector placed toward the front edge of the bench and no more than four feet above it, 40 footcandles may be supplied with a minimum of 2250 lumens, providing a highly efficient reflecting surface is used, Figs. 37 and D-I.* Thirty-degree shielding below the horizontal is desirable. When there is prolonged or very critical work, higher levels are required. Directional light of high level may be gained by the added use of portable and adjustable devices.

4.8.2—*Game Tables*—**(a)** In medium-sized areas (see Table IV) with the recommended general lighting and local lighting at four to six furniture groupings, there is usually no need for specific game table lighting or for moving portable luminaires to the table. When there is a fixed location for the card table, a ceiling recessed downlight may be used. In recreation centers, an appropriate general lighting system may be planned to provide 10 or more footcandles on a 30-inch horizontal plane throughout, see Fig. 52.

TABLE IV.—Room Description in Total Area.

Room Classification	Area (square feet)
Very small rooms (such as vestibules, halls, baths, and closets)	Under 60
Small rooms	60 to 125
Medium rooms	125 to 250
Large rooms	250 and over

(b) For table tennis (ping-pong) tables used for relatively unskilled and recreational play,[24] two luminaires may be centered lengthwise over the table five to six feet apart, although other sources in the area are required for low levels of surround lighting. Incandescent-filament lamps (150-watt inside-frosted) in deep-cone shades of metal or paper, minimum shielding 20 degrees, or fluorescent direct or semi-direct luminaires for two 48-inch lamps, are suggested. The fluorescent lamps need shielding to 30 degrees below the horizontal crosswise and 25 degrees lengthwise. For faster and more skilled playing, two additional units beyond the ends of the table are needed, and should be located five to six feet out from the over-table ones. When beams or joists prevent lengthwise placement, fluorescent luminaires can be placed crosswise of the table, two spaced eight feet apart for unskilled play, and four placed six feet apart for skilled play. In lengthwise mounting, an eight-foot luminaire reduces the number needed, Fig. 38.

4.8.3—*Television Viewing*—A moderate level of general room lighting is important for eye comfort in viewing television. The ranges of brightness of the correctly adjusted picture tube are 10 to 30 times greater than those of motion-picture theater screens, and darkened surroundings are not necessary for clear, high contrast pictures.[25] The average picture tube brightness (10 to 20 footlamberts with highlights up to 100 footlamberts) is visually tiring in contrast with dark surroundings. Several portable luminaires may be arranged to provide balancing lighting throughout the room without directing light to the screen. With luminaires using two-filament lamps, the low or medium light level may be used. Shades in the field of view should be opaque or very low brightness (50 footlamberts approximate maximum). Luminaires, chairs, and receivers should be posi-

Figure 39. The narrow wood framing of the screen and the added back lighting combine to provide some of the basic conditions for visually comfortable television viewing. Size of lamp behind set varies with wall reflectance and space between wall and lamp, to maintain low contrast between the picture and its immediate visual surroundings. See 4.8.3.

tioned to avoid light source reflection in the picture tube. Lighted valances or cornices provide excellent viewing conditions when they are not in the field of view. See Figs. 39 and 58.

4.9 — *Circulation* — Sure and quick seeing for safe passage into and throughout the interior is essential. Lighting requirements for this purpose are far less exacting than for close visual tasks. Accordingly, no illumination planes are specified, nor are quantitative levels for all the areas which require lighting attention. A low order of illumination (five foot-candles) provides normal safety. Luminaire brightness and lamp shielding are of less significance than in areas where persons remain over more extended periods, provided the luminaire is not within the normal viewing angle. Suitable luminaire types must insure light distribution over the area being traversed.

4.9.1—*Exterior* — **(a)** Light on the outside of the house at every doorway should assure both safe passage to the door and ready recognition of the person outside. When architecturally appropriate for the front entrance, a pair of wall brackets (40 to 60 watts minimum) are most satisfactory, provided they use etched or diffusing material, give some downward light, and are mounted 66 inches above the house floor. A single bracket is placed on the opening side of the door. Flush or ceiling-attached luminaires are often applicable, Fig. 40, but if steps are not adjacent they require additional lighting. Lighted house-numbers, visible from the street, are thoughtful courtesies. Numerals should be three inches high with a half-inch stroke, to be visible at 75 feet.

(b) Additional lighting may be necessary or desirable for protection from night prowlers, for driveway lighting, yard floodlighting, garden viewing, and sports. Some directional component for driveways and sports areas may be added with luminaire types usually associated with street lighting. Directional floodlighting may be provided with suitable spots or floods, Fig. 41. Mounting these luminaires on the side of the building usually provides sufficient illumination. Pole-mounted luminaires may be used for all-around lighting.

4.9.2—*Garage*—For the greatest safety in entering or leaving automobiles in garages, ceiling sockets with a minimum of a 100-watt incandescent lamp may be located at both sides of the car, approximately six feet back from the front bumper. This places the lamp above the front car doors and thereby minimizes shadows cast in the passage. In two- or three-car garages, the lamp or lamps between the cars may, if desired, be placed high on the wall between the garage doors to provide light back of the cars. Convenience outlets at the front and the rear of the garage allow use of a "trouble" or flood lamp to look into the car engine or trunk.

4.9.3—*Closets* — In closets that are more than nine square feet in area, or more than two feet deep, a socket placed above the door or on the ceiling close to the door center is essential (minimum 60-watt). For walk-in closets, the outlet (minimum 100 watts) is centered in the ceiling; reduction in the harshness of light and in density of shadows is gained by use of coated or silvered-bowl lamps, or luminaires.

4.9.4—*Halls, Passages, and Stairways*

Figure 40. With ceiling or roof overhang at entrances, a flush or attached direct lighting unit (minimum 800 lumens) is applicable. If placed close to the doorway, it provides better viewing of the visitor from inside. The 8-inch square box with frosted glass uses a 75-watt lamp. Since steps are not clearly lighted by the entrance light, individual riser recessed units are used. When doorway is set back from front walls, a flush unit, nearly the width of the door, is most effective.

—In vestibules and halls, up to 60 square feet, small luminaires (minimum 450 to 850 lumens) serve. When shallow closets open into the area, higher light output, up to 1600 lumens, is required. Bare lamps with highly diffuse coatings are applicable where appearance does not demand a more complete luminaire. In front entrance halls, where the luminaire more frequently remains lighted throughout the evening, and where it is in view of persons occupying adjacent living areas, reduced brightness is more important. Complete lamp shielding by highly diffuse materials is then recommended. Glass diameters of no less than 10 to 12 inches are recommended for typical luminaires which use lamps generating 1350 to 1600 lumens. For narrow passages over 12 feet in length, two ceiling luminaires are required, and for longer lengths luminaires should be spaced on about 10-foot centers. About 45 to 85 light-source lumens per linear foot should be used, depending upon distribution and lumi-

Figure 41. Weatherproof swivel-socket or fixed brackets for (a), above left, projector floodlamps, or (b), above, regular lamps with directional reflectors or (c), left, prismatic refractors extend outdoor living at night. See 4.9.1 b.

naire efficiency. Incandescent or fluorescent brackets, lighted cornices, or coves are applicable when a more decorative treatment of the area is desired. At enclosed stairways, a ceiling luminaire, with a minimum of 850 lumens, should be located at the top and bottom; if the stairs turn sharply, a third luminaire is usually needed. With open stairways, it is often more appropriate to center the luminaire on the adjacent hall ceiling, Fig. 42. The luminaire must then have a higher output, and the proper light distribution to compensate for its distance from the stairs, and must provide shielding of the light sources sources from all possible viewing positions in traversing the stairs.

Figure 42. (left) Two 12-inch luminaires, three 40-watt each, provide safe stairway lighting in the narrow hallways. The upstairs luminaire (not shown) is located above the rail. A 1½-inch opening between the luminaire glass and the ceiling provides desirable upward light with complete lamp shielding from any point on the stairs. A night night at the top step is a needed safeguard. See 4.9.4.

Figure 43. With 40-watt shaded lamps, the candle-type chandelier, ever appropriate in suitable metals or crystal for traditional dining rooms, provides 5 to 15 footcandles over the table top. A pair of double-arm matching brackets flank the fireplace, not shown. In some candle-type luminaires, additional clear lamps are cleverly concealed in bobeches or the fixture body for subtle increase in table illumination and sparkle.

4.10—*Dining*—(a) When the dining area is used solely at meal time, illumination level on the table as well as luminaire selection becomes a matter of personal taste and decorative suitability. However, meal service is facilitated and a more pleasant atmosphere is gained if the table illumination is not below five footcandles. Brightness ratios may be considerably higher than when critical visual work is done, although the discomfort that arises from extreme differences in brightness should be avoided. Luminaires of all light distributions and hanging positions apply, and there is wide choice of all types. Those which include a strong downlighting component are most effective in creating table highlight and sparkle. Figs. 43-47.

(b) In small dining rooms or dining alcoves, the table is frequently not centered in the area, but the luminaire should be centered with respect to the table. If the table is markedly off room center, a recessed lighting treatment is often most suitable. Recessed downlights, Fig. 45, with one- to six-inch apertures are effective. Custom-built luminous panels or coffers approximating table size provide

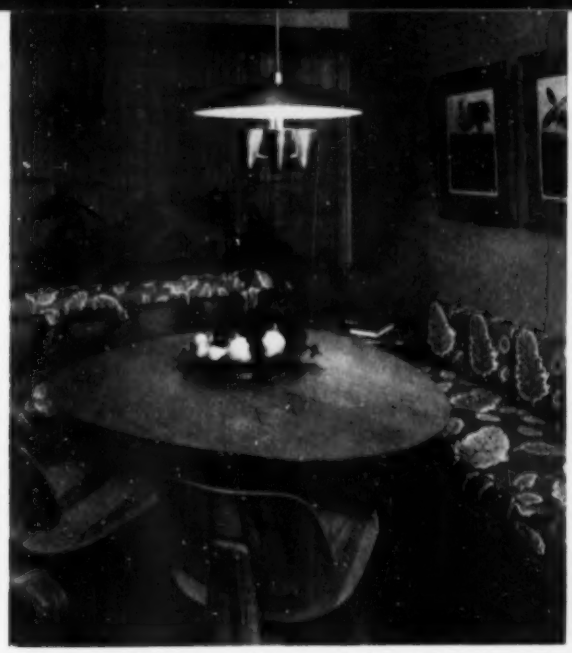


Figure 44. Many attractive new designs in low — or adjustable — hanging luminaires provide confined table lighting, average 5 to 15 footcandles. Higher illumination may be obtained when the lampholders are designed to provide direct lighting through louvers or lens plates. Comfortable brightness depends on light output, spacing of lamps from canopy and contour of canopy. Unless the latter is pierced or of translucent material to allow some light to reach the ceiling, brightness ratios are excessive without other means of indirect lighting, *provided here by a wall-length cove opposite the window.*

Figure 45. (below) This pin-hole spot, 1½-inch aperture, includes adjustable lens and shutters to fit the light beam to the table top, uses 100-watt 20-volt bayonet base lamp and transformer. Fifteen footcandles on table top, 5 feet beneath; additional 5 footcandles from cornice lighting on two walls (5.2.3.3).

Figure 46. The 6-inch lens plate used in this three-effect luminaire is designed for the R-30 75-watt lamp (flood distribution here). The 9-foot lighted valance, two 40-watt deluxe warm lamps, creates needed background lighting and also supplies about 10 footcandles on the table when it is placed beside the window. Higher reflectance draperies would create greater luminosity. With the five 40-watt lamps added in the fixture bowl, about 40 footcandles are produced on the small table beneath for pattern cutting, sewing, sorting and games, about 20 footcandles with smaller lens plates or with 75- or 100-watt inside frosted lamps. This type of fixture is not recommended for prolonged reading or study at the table.

Figure 47. This type luminaire incorporates the lighting requirements for critical reading or study at the dining table, although its position ahead of the user is not desirable (4.3 and 4.3.3). The shade conceals an open-top 10-inch diffusing bowl, average 1400 footlamberts and 100/300-watt lamp for either low illumination for dining or about 40 footcandles at distances no greater than 2 feet from the table center; bottom of shade 36 inches above table.

less brilliance, but flattering lighting. They also offer the possibility of varied light levels as well as color effects. However, recessed boxes which are considerably smaller than table size create somewhat harsh lighting. Like any totally direct lighting system of limited distribution, some indirect lighting from other sources in the room is recommended. In fact, the degree of flexibility in lighting effects usually desired in dining areas suggests the use of other than table-lighting luminaires. Typical auxiliary lighting media are decorative buffet table lamps, torcheres, wall brackets, or lighted valances, cornices, or coves.

4.10.1—*Use of Dining Space for Visual Activities*—**(a)** In many homes the dining table is also used for a diversity of visual activities. For these, an illumination level over the table top of no less than 20 footcandles should be available and brightness ratios in the visual zones (2.1.3) should be related. This level is minimum for most visual tasks, and assumes that the tasks are of moderate duration. Few luminaires of current manufacture supply 20 footcandles unless they incorporate a highly directional component, Fig. 46, or are hung low, 30 to 36 inches over the table, Fig. 47. The former is provided in recent incandescent luminaires by a central lens plate four to six inches in diameter. There is, however, considerable variance among those now available in light distribution and brightness control, because of differences in optical characteristics of the lens and relation of the lamp to it.

(b) Use of the dining table for extended reading or study should be discouraged unless all conditions for visual comfort are present. The location of the luminaire over the table center and ahead of the user produces annoying source reflections. The same conditions pertain as with desk luminaires directly in front of the user (4.3.3). If the table must be used for study, the luminaire must incorporate highly diffuse direct lighting as well as a large proportion of indirect lighting, Fig. 47. Even this type of luminaire can seldom supply the recommended 40 footcandles at distances greater than 24 inches from the center of the table (luminaire hung with its lower edge 36 inches from the table top and supplying 4600 lumens). An auxiliary table or floor luminaire of the types suggested for reading is needed to reduce specular reflections.

4.10.2—*Brightness of Dining-Area Luminaires*—While a close-to-ceiling luminaire placed over the table center is outside the normal viewing angle of those seated at the table, brightness control is essential to provide visual comfort for those moving about the room, seated away from the table, or viewing it from adjacent areas. With suspended luminaires, the luminous portions of which are materially less than seven feet above the floor, even lower brightness is required since the luminaire is closer to the eyes and the line of sight of persons seated at the table. See Section 5.2.1.2 for brightness recommendations for ceiling-attached luminaires.

5. Lighting for Task Surroundings

5.1 — *General Considerations* — (a) Lighting in the visual task surroundings (Zones 2 and 3) is no less important than for the task areas. The surround or general lighting is intended to augment the local lighting for less spotty effect. It aids in attaining recommended brightness ratios within the visual zones during periods of close eye application (2.1.2 and 2.13). In addition, it provides illumination throughout an interior for moving about and for general housekeeping pursuits. Some methods of general lighting, notably those discussed in 5.2.3 and 5.2.4, afford a pleasing atmosphere for conversation, music, or other periods when there are no close vision demands. The recommended levels, Table I (B), are to be considered average minimum values. Uniformity of illumination need not be an objective. On the contrary, moderate variations create a more pleasing pattern of light and shadow. A basis of estimating lumen or luminaire requirements for obtaining generally satisfactory light distribution is given, when practicable, for each of the discussed general lighting methods. When more exact computation of illumination levels or uniform illumination in an area is desirable, candlepower distribution curves of the luminaires under consideration must be obtained[27] and calculations made in accordance with established formulas.[14]

(b) The whole burden of supplying general lighting levels need not be carried by the general lighting system. Many of the luminaires which provide task lighting contribute to general lighting. The degree depends upon their proportion of indirect lighting and their breadth of light spread, either upward or downward. However, a system which provides the recommended average room illumination independently of the specific task lighting is desirable. It lends insurance for visual comfort, convenience, and adaptability of the lighting to varied living needs. In some cases, general lighting may be well supplied entirely by the task-lighting luminaires. This is notably so in halls and passages (4.9), in very small bathrooms (4.7.1), in laundries (4.6), and in the areas where an extensive inbuilt system is planned for the purpose as illustrated in Figs. 6 and 52. Portable luminaires, in the areas where they have best application, may also supply surround lighting. The room area must then generally be less than 350 square feet with average ceiling height, and with interior finishes at the higher values of the recommended ranges (2.2.1). Four to six portable luminaire are required, and each must direct about half of its light upward. With incandescent-filament types, Table III, a minimum total of 600 watts is average for small rooms — 900 to 1200 watts as room area increases to 350 square foot. See Fig. 58.

5.2 — *Methods of Task-Surround Lighting* — The several systems discussed here differ (1) in initial cost, (2) in efficiency, (3) in ease of maintenance (Appendix E*), (4) in degree of illumination uniformity, (5) in sensation created by the environmental effect, and (6) in suitability to individual interiors. Many factors thus influence choice, such as economic considerations, personal taste, the dimensions of the room, and its interior design. Interiors of earlier period treatment need not utilize solely luminaires typical of the period, Fig. 50. Too often they handicap today's living and seeing requirements. Present-day lighting techniques based on these goals can, with design skill, be tastefully adapted.[10]

*Published in reprint only.

5.2.1 — *Ceiling-Attached Luminaires* — **(a)** The relatively low cost of this method of general lighting gives it practical application in every room of many homes,[13] and recent styling development of ceiling-attached luminaires is increasing their acceptance. Simplicity of design, shallow form, and near-to-ceiling positioning foster the trend. But more study and creative design are needed for greater progress in their lighting performance.[26] The symmetrical character of their light distribution, of whatever type (Appendix D*), limits the use of a single luminaire to nearly square and medium-sized rooms. Two or more are required when (1) the total area exceeds about 250 square feet, (2) the length of a room is approximately 60 per cent more than its width, or (3) the lumen requirements exceed the capacity of a single luminaire to utilize the needed lamp sizes without excessive bulkiness or brightness. If the use of more than one is undesirable, other general lighting methods should supplement or replace it.

(b) The lamp lumens required to produce an average general lighting value of *approximately five footcandles may be estimated on the basis of 15 lumens for each square foot of room area.* For example, in an 11 x 14-foot bedroom, the luminaire should accommodate lamps which emit about 2300 lumens, Fig. 48. See Table C-I, Appendix C*, for lamp sizes and approxi-

Figure 48. In this typical modest bedroom (150 square feet; 8-foot ceiling), the 16-inch square white ceramic-enamelled glass fixture uses five 40-watt lamps and provides an average general illumination of 5 footcandles. The contour of the fixture and the 3-inch spacing between it and the ceiling confines the ceiling spread of light. Average brightness of luminaire is about 400 footlamberts, indicating lamp lumens are at a practical maximum. A 33-inch fluorescent bracket over each bed completes the local lighting, with the three appropriate lamps placed for sewing and make-up.

Figure 49. Ivory opal glass of higher density than the white enamelled glass luminaire shown in Fig. 48 allows the use of five 60-watt lamps for a higher average general illumination (10 footcandles) without creating any greater average luminaire brightness. The 7-inch spacing between luminaire and ceiling is sufficient to provide relatively wide ceiling distribution. The fluorescent wall bracket (two 33-inch lamps) provides 30 footcandles for reading in bed. (See 4.3.2.) The illustrated unit is one example of a packaged prefabricated valance.

mate lumen output. The basis for this method of planning assumes (1) typical distributions of representative residence luminaires,[27] (2) reasonably good luminaire efficiencies, 65 to 80 per cent, (3) recommended room reflectances, and (4) the size and shape of residence rooms in which ceiling luminaires are best suited. For the more functional rooms, such as halls, kitchens, bathrooms, and many play areas, general-diffuse or predominantly direct lighting distribution is highly suitable. But where visual pursuits are less physically active and persons are seated for longer periods of time, a considerably higher proportion of upward light is recommended.

5.2.1.1—*Design Factors—Ceiling-Attached Luminaires*—**(a)** Prevalent lower ceiling heights and interior design trends have forced a close spacing between the luminaire and the ceiling, with consequent sacrifice of the full advantage of indirect distribution. In high-ceilinged areas and over dining tables, suspended luminaires apply. And in contemporary interiors, adjustable, low-hanging ceiling luminaires often replace portable luminaires; in such cases they cannot be considered as general lighting luminaires. A minimum spacing of 4 to 12 inches between the top of the luminaire and a 7- to 9-foot ceiling is desirable for types with an upward component. Better lighting performance as well as the illusion of closer spacing and of desired integration with the ceiling is achieved in several ways: (1) a luminaire contour which harmonizes with the ceiling plane, (2) increased luminaire size, (3) moderate average brightness, and (4) avoidance of obtrusively bright areas adjacent to incandescent lamps. The last-mentioned depends upon the transmitting and diffusing character of the shielding medium and upon the space between it and the lamp or lamps.

(b) Highly-diffuse shielding media are recommended, such as flashed opal glass, ceramic enamelled glass and some plastics. High-density glass or plastic is needlessly inefficient except when the luminaire provides a high indirect component and is used against a ceiling of high reflectance, Fig. 49. Etched or configurated glass and low-diffusing plastic is not recommended except for (1) fluorescent luminaires, (2) circulation areas, or (3) purely decorative incandescent luminaires where low wattage or colored lamps insure tolerable brightness, Fig. 50. Even with glass or plastic of excellent diffusion, "spottiness" and often excessive brightness occur if incandescent lamps are widely separated or are too close to the shielding medium. The brightness of the shielding adjacent to the lamps may be reduced as much as 50 per cent by increasing the spacing between the glass and lamp from one-quarter to three-quarter inch.

5.2.1.2—*Brightness Values—Ceiling-Attached Luminaires*—**(a)** The need to reduce objectionably-high-brightness areas of a ceiling luminaire does not imply that it must be without brightness variation. On the contrary, there is much appeal in, and thus popular demand for, a degree of sparkle and "liveliness." The design challenge is to achieve this without a total luminaire brightness which extensive researches and experienced appraisals find is uncomfortable or distracting to the majority of persons. The sensation caused by a given brightness can vary over a wide range, from discomfort to comfort, depending chiefly on (1) the position of the eye with relation to the source, (2) the direction of the line of vision, (3) the brightness level to which the eye is adapted,[15] and (4) the area of the source of brightness. Thus the recommendation of a limiting value for a practical guide to brightness design requires some arbitrary selections for these variables. For one example, as the eye is moved farther from a luminaire, it can stand a higher brightness because the visual size of the luminaire decreases. This would mean that for every position of the eye in a room, the luminaire could have a different maximum value of brightness for equivalent comfort. The factors that guided the establishment of these variables came from published studies,[28] interim researches,[15] tests on a limited number of new and representative luminaires and from experienced analysis of associated home conditions.

(b) For luminaire appraisal and for the measurement of *average* brightness,* expressed in footlamberts, the selected eye location is 40 inches above the floor and six feet horizontally from a point beneath the nearest edge of the luminaire. A luminaire, the major luminous portion of which hangs seven to eight feet above the floor, is located at an average of about 32 degrees

*Average brightness in footlamberts is determined by measuring the candlepower at the eye position and normal to the luminaire, dividing it by the projected area[29,30] in square inches, and multiplying the result by 452.

Figure 50. Etched and clear glass chimneys typical of Colonial luminaires are uncomfortably bright unless tinted 15-watt to 25-watt lamps are used. These luminaires were selected solely for harmony with the room's decorative scheme; downlights at the refreshment bar, fluorescent cornice and ceiling recessed luminaires in the play area supply the basic lighting. See 5.2.1.1b.

Figure 51. Ceiling-recessed box is 12 inches square and 8 inches deep, 75-watt incandescent lamp, and provides slightly more than 5 footcandles. Generous box dimensions for lamp size and opal glass combine to produce sufficient light spread for some wall illumination in the 5½-foot square vestibule without excessive luminaire brightness. See 4.2.3 and 5.2.2.

above the horizontal sight line. Although it may be viewed directly for short periods, a brightness value for comfortable direct viewing may impose impractical size and costs for the needed illumination levels. Therefore, the suggested brightness limit makes some though not full allowance for a luminaire position above a horizontal viewing direction.[15] An eye adaptation level of 15 footlamberts is assumed. This approximates the average brightness of most tasks when they are illuminated to the recommended minimum footcandles. The physical sizes of currently-manufactured residence fixtures vary greatly. Many are too small to be effective sources of general lighting except in areas under about 100 square feet and when more than one is used. Thus sizes more appropriate for rooms over 100 square feet are used as a practical basis. These should accommodate a total of approximately 150 to 300 watts in incandescent lamps, or 50 to 100 watts of fluorescent. Typically they range from 16 to 24 inches at the widest dimension for incandescent types; 25 to 50 inches for fluorescent. Popular shallow form is also assumed.

(c) Within the stated conditions, the following brightness values are suggested. The average brightness of the *total luminous area* of the luminaire should not exceed 500 footlamberts for luminaires designed for other than the utility room; 800 footlamberts for the more strictly utility spaces. Etched lines or small pattern, minute clear cuttings, crystal segments, or grills which create the desired sparkle are permissible if they do not exceed 9000 footlamberts, the individual area of each not exceeding 0.25 square inches. Within the diffuse area, the brightness of the brightest square inch should not materially exceed twice the average. In any standing position out to 20 feet away with the eye level at 64 inches, bare lamps should not be visible over the top of the luminaire. An average brightness which is 25 to 50 per cent lower than the limiting values given above is very desirable, and especially so where

(1) luminaire size exceeds the ranges stated above,
(2) eye adaptation level is lower than assumed here,
(3) the luminaire is hung lower than 7 feet above the floor,
(4) the luminaire may be habitually viewed directly from reclining positions, or where
(5) prolonged critical visual work is regularly performed.

Similar increases in average brightness are permissible when these associated factors are reversed. In all cases the brightness ratio between the luminaire and the adjacent ceiling should not exceed 20 to 1. When current studies on the complex subject of comfort and visibility, as affected by brightness patterns, are completed, related studies of residence luminaires may indicate changes in these present recommendations.

5.2.2—*Ceiling-Recessed Luminaires*—**(a)** Characteristic design, lighting effect, and installation features of these luminaires (at least of available if not of custom-built types) restrict their use as a means of general lighting. With lamp location above the ceiling, light distribution is totally direct and confined to limited areas beneath. See Sections 4.2.2 and 4.2.3. Thus, to avoid excessively sharp variation in horizontal illumination and to attain distributions approximating those of recommended ceiling-attached types, two to four times as many luminaires are required. A single one is never advised, except in very small rooms, and then usually because it also supplies the appropriate lighting for some specific seeing requirement, Fig. 51. The lighting effect created by and the appear-

Figure 52. The recessed fluorescent luminaires (5.2.2) in this general living and play area, 15 x 25 feet with 8-foot ceiling are selected and spaced *primarily* to deliver nearly uniform and highly diffuse illumination, 30 footcandles, for variety of games and visual pursuits; equivalent levels for general lighting result. Five rows are required, each containing two end-to-end units (two 40-watt lamps each). Additional wall illumination is not required but is desirable for decorative values and for alternate environmental effects; obtained by a 25-foot lighted cornice, six 40-watt lamps, on wall shown, and on opposite wall by 20 feet of lighted valance. All lamps deluxe warm white.

Figure 53. A tailored variation of the more usual recessed luminaire is this oval coffer, formed in a dropped ceiling 11½ inches below the actual ceiling. Four 40-watt fluorescent lamps, 2 pink, 1 blue and 1 white, indirectly light the coffer and result in 5 footcandles. The white lamp is placed also for edge-lighting glass partition at the left. Side wall of cavity, 30 per cent reflectance, seen from seated positions in connecting living space has maximum brightness of 35 footlamberts. See Section 5.2.2e.

ance of typical recessed luminaires usually makes them more appropriate for work or active play areas or for functional contemporary interiors, Figs. 6 and 52. Other lighting media which supply more vertical illumination (on walls) and contrast-relieving ceiling illumination are almost always desirable. Ceiling and floor reflectances at the higher values of the recommended ranges (2.2.1) are particularly important. Finally, since recessed luminaires are a part of the structure, they must be skillfully planned[29] and exactly specified[30] in the very early stages of construction or renovation. Proper wiring and installation preparation requires full information on location of joists, ducts, and bracings and on vertical clearances above the ceiling.

(b) The selection of the luminaire type depends upon the effect desired and the uses of the interior, Appendix D.* The number and spacing of luminaires must be calculated from established formulas[14] based on the desired illumination level, and uniformity, and upon the distribution, lumen capacity and efficiency of the selected equipment. Design features which affect lamp shielding and luminaire brightness are discussed in 4.2.2 and 4.2.3 and have equal bearing on general lighting application. Recommended brightness values are subject to the same variables as in the case of ceiling-attached types, 5.2.1.2. Lower average brightness for equivalent luminaire sizes is desirable; otherwise the suggested brightness ratio of luminaire-to-surrounding-ceiling (20 to 1) is difficult to attain.

(c) Custom-designed variations from the commercially available recessed luminaires offer possibilities for more decorative and versatile treatments. Fig. 53 illustrates one example. The growing interest in *architectural* forms of lighting for the home, as well as the increasing demand for higher-level and higher-quality lighting, has fostered the use of complete ceilings as a "lighting fixture." This type of installation is known as a louverall[31,7] or a luminous ceiling, depending on the use of louver-shielding, Fig. 54a, or of diffusing light-transmitting material below the lamps, Fig. 54b.

5.2.3—*Wall-Applied Luminaires*—**(a)** The inherent asymmetric distribution of wall-applied luminaires creates lighting effects quite unlike the methods previously discussed. In effect, they illuminate sufficient portions of the walls and ceiling for redirection of light throughout the room. Therefore, to achieve effective illumination and comfortable wall brightness, wall reflectance in the 40 to 50 per cent range and ceiling reflectance of no less than 70 per cent are recommended. Wall luminaires produce horizontal footcandle distribution that differs from that of ceiling luminaires, providing considerably higher illumination close to the walls, and less toward the center. This distribution is more important for achieving lower brightness ratios in the visual zones, 2.1.2, than is

*See reprint.

Figure 54a. Clerestory construction above this 65-square-foot kitchen forms a 10-foot ceiling and provides the only daylight. Needed control of daylight and an effective means of electric lighting are gained by use of 9-inch white wood louvers spaced 11 x 12 inches. The glossy, high-reflectance ceiling on which fluorescent lamps are mounted and the 2½-foot spacing between lamps and top of louvers make possible good brightness pattern of louvers with only five 40-watt lamps, placed diagonally; average illumination is approximately 40 footcandles. Fluorescent brackets illuminate space between the cabinets and add variety to brightness patterns and increase light at counter and range. See Section 5.2.2 c.

Figure 54b. This remodeled semi-circular porch (10-foot radius) employs twelve 40-watt white fluorescent lamps mounted 10 inches above ribbed frosted glass. The resulting luminous ceiling (8 feet 6 inches above the floor) provides 35 footcandles average illumination.

the provision of horizontal footcandles in the central portion of the room. The extended linear types of luminaires in particular supply interesting cross lighting, similar to the effect of daylight through windows.

(b) The more conventional types of wall luminaire using single or multiple urns or shaded candles, have lost popularity except for decorative effect in traditional rooms. The numbers needed — a pair on each wall — for effective general lighting, and the limitations they frequently impose upon furniture placement and wall treatment are disadvantages. Their limited light spread tends to create patches of brightness in disturbing contrast to the rest of the wall, Figs. 55 and 8. The 40-watt lamp is the practical maximum consistent with comfortable adjacent wall brightness, unless the lamp center is at least four inches from the wall. In areas where 7-foot ceilings exist and budgets are limited, there is need for modernized versions of these small incandescent brackets with increased control in spread of upward and downward lighting. Larger-scaled indirect urns, suitable for larger or high-ceilinged areas, are designed for 100- to 300-watt lamps and should in-

Figure 55. Flexible lighting of 300-square-foot recreation room includes easily removable units for table tennis, 150-watt each for 35-50 footcandles over play area; two torcheres, 300-watt each for card tables at end of room not shown; and four balanced pairs of double-arm indirect wall luminaires, 25-watt each socket. This lamp size causes less brightness difference between opaque urn and adjacent wall and creates more appropriate effects for dancing than does 40-watt lamp. See Section 5.2.3 b.

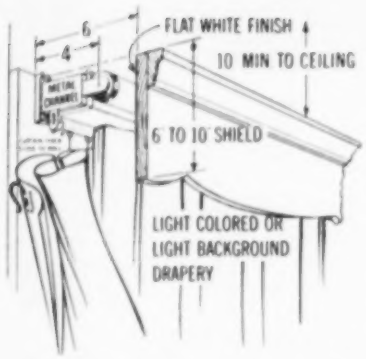


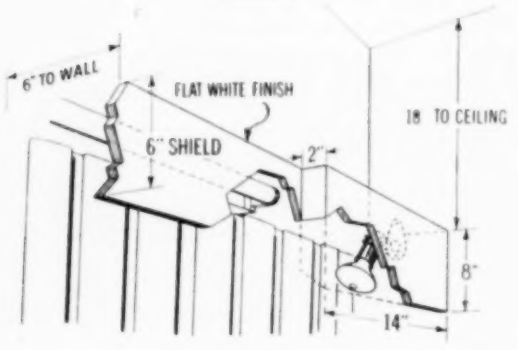
Figure 56. Essential arrangement and dimensions of parts for satisfactory general lighting service from window or wall-to-wall valances and linear brackets. When channel or hanging method does not locate lamp as shown, wood blocking may be required to center the lamp at least 4 inches out from the wall. See Section 5.2.3 c.

clude baffles or reflectors for control of adjacent wall brightness.

(c) The newer linear wall luminaires may use either incandescent lumiline or fluorescent sources. With installations of more than 15 feet, fluorescent lamps are generally advantageous because of the fewer lamps required and the more efficient use of electricity. In some traditional rooms, however, the more yellowish light of the lumiline lamp may be considered more appropriate. When the truer color-rendition fluorescent lamps are used, and they are generally preferred, the two sources (with the exception of the higher-efficiency 40-watt fluorescent lamp) supply approximately the same lumens per foot. Various methods of application are discussed in the following paragraphs. Each creates more extensive "washes" of wall lighting than non-linear types, and is generally more adaptable to contemporary wall treatment. When correctly applied, they are dependable sources of both comfortable lighting in the surroundings for close visual work, and appropriate lighting throughout an area for periods of relaxation, conversation and other activities which do not depend upon close or critical vision.

5.2.3.1—*Lighted Valances*— **(a)** Valances have long been used to unify drapery treatment at windows and doors. With some adjustments in design, a valance creates a natural location for linear light sources without introducing obvious lighting mechanics.[7] Valances may be of the prefabricated type or custom-built. The proper arrangement of electrical parts, with relation to the valance top and to the ceiling, shown in Fig. 56, assures effective light distribution on the ceiling. When there is less than 10 inches between the valance top and the ceiling, it is generally desirable to provide a top covering, sacrificing upward light. A minimum spacing of four inches between lamp and wall is essential; a greater spacing results in better light distribution down the wall. Sufficient projection of the valance to provide this distribution is more acceptable decoratively if the valance extends the full length of a wall, Fig. 57, or is at least 12 feet long. The wiring channel is located on or just above the window frame, typically seven feet above the floor. It may be permanently wired to an electrical outlet or may be connected by an extension cord to a convenience outlet so that it is easily removed. At the usual mounting height, a minimum six-inch shield depth provides the maximum spread of downward light consistent with 45-degree shielding. Greater valance depth is often decoratively desirable, and is mandatory for deeper lamp shielding when window or door heights require higher than 7-foot mounting. When more than one lamp is used, the sockets should be back to back to avoid dark streaks between lamps on the wall above. Lamps of the same diameter and color should always be used for uniform effect. Drapery fittings should be placed as near to the wall as possible and never more than two inches out from the wall. Deep pleating is not desirable if an even distribution of light over the drapery surface is to be attained. If

Figure 57. Small alcove, 48 square feet with 9-foot ceiling, is seemingly enlarged by 8-foot wall-to-wall valance and traverse drapery covering two small windows. Two end-to-end 33-inch deluxe warm fluorescent lamps are used; in end sections, as shown below, are separately-controlled 75-watt adjustable spot lamps for varied uses in this hobby center. Lighted valance supplies generous surround lighting for concentrated spotlighting of sewing machine; 100 foot-candles at needle from spot lamp at left end and valance.



draperies are not of the traverse type, glass curtains or other window shading with favorable reflectance, Fig. 58, are needed to obscure the non-reflecting window surface, which is black at night.

(b) Larger window areas in contemporary homes increase the possibilities of this means of general lighting. There is also a trend to carry drapery fittings beyond the window frame both to obtain greater use of daylight and to extend window treatments. Thus, valance lengths often make it possible to use sufficient lamp lumens to provide effective general room lighting. Experience with this form of lighting has shown that it may be well designed on the basis of *approximately 30 to 45 lumens per square foot of room area.* This range allows for variation in reflectances and in room use, as well as for adjustment of lamp lengths to valance lengths. See caption, Fig. 59. A guide to total lamp length for various room areas to provide the required lumens, is given in Table V. The total suggested footage need not be made up solely of valances, but may include coordinating linear brackets or lighted cornices. When architectural or decorative conditions or costs limit the footage to less than that suggested, an attractive installation may still result. However, supplementary general lighting methods are usually essential to obtain recommended average illumination values. Some situations, conversely, suggest the use of somewhat greater lengths than noted in Table V. Substantial increases should be weighed carefully in terms of room proportion and possible monotony of lighted effect.

(c) Fluorescent lamps emitting more than 500 lumens per foot require a spacing greater than four inches from the wall, or lower wall reflectances than suggested (5.2.3). Otherwise the brightnesses of the surfaces just above or below an opaque valance will exceed the recommended maximum of 100 footlamberts. Transmitting materials may be used for the valance if they are sufficiently dense to restrict the brightness to 200 footlamberts, preferably less.

Figure 58. While the lighting arrangement of six portable luminaires (total 1050 watts) provides an average of about 5 footcandles in the room, two lighted window valances were added for desired increase in general lighting and for their environmental effect without the portable lamps. Fabric-covered and formed for harmony with 18th Century treatment, the one shown uses two 40-watt deluxe warm fluorescent lamps. Another longer one at bay window at the left behind sofa and opposite television set uses four 25-watt lamps.

5.2.3.2—*Lighted Linear Brackets*—These have the same basic form and lighting design requirements, Fig. 56, as lighted valances. Instead of being used as framing heads of window or door treatments, however, they are applied to plain wall sections, Fig. 59. They are not combined with draperies, and there is therefore, more space between the lamps and the vertical surface behind them. A smoother distri-

Figure 59. Linear brackets applied to plain walls produce similar effects to lighted valances and also serve to highlight furniture groupings or wall treatment. The minimum recommended lamp length, 33 inches, is used here in a very small dining alcove behind a 38-inch shield. The lamp or lamps used in any linear wall luminaire are always centered lengthwise in the shield; unlighted space at each end should generally not exceed 10 inches with 3 to 6 inches preferred.

TABLE V.—Guide to Approximate Lamp Footage* per Room Required for General Lighting from Linear Wall Lighting Elements.

Range in Room Area Square Feet	Range of Total Lamp Length Feet
Very Small — Up to 60	2½ to 6
Small — 60 to 125	6 to 12
Medium — 125 to 250	12 to 24
Large — 250 to 600	24 to 60

*Based on use of light sources averaging approximately 400 lumens per foot.

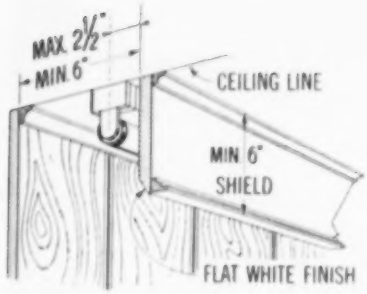


Figure 60. Cross section showing minimum spacing and arrangement of electrical parts for a lighted cornice. Depth of cornice depends on ceiling height for adequate lamp shielding as well as upon architectural proportions; the 6-inch depth applies only to rooms with ceilings of 8 feet or less. On long walls or with cornice-to-wall spacing in excess of about 10 inches, louvers may be required for lengthwise shielding of lamps. See Section 5.2.3.3.

bution of light results. They are especially effective in low ceilinged rooms since they may be mounted as low as six feet above the floor.

5.2.3.3—*Lighted Cornices*—Decorative considerations often dictate the application of the light strip to the ceiling with a dropped cornice concealing the lamps, Fig. 60. The resultant lighting effect is somewhat different from that

Figure 61. In this contemporary dining room, 195 square feet, 8½-foot ceiling, a continuous four-wall cove produces about 8 ft-c over the table top. Fifty-two feet of 12mm cool white fluorescent tubing, with remote location of transformers, are used; upper walls and ceiling are a delicate shell-pink. Tubing is placed about 6 inches from wall and 14 inches beneath ceiling, maximum brightness 50 footlamberts. Pin-point spotlight provides table accent; linear incandescent lamps are concealed behind cove and above drapery across window wall.

Figure 62. The 18-inch spacing between the top of the coves and the 7-foot ceiling and the narrow room width result in an exceptional spread of ceiling lighting. The coves extend approximately the full length of the long walls, 29 feet; average illumination throughout, 5 footcandles. The use of standard warm white 40-watt lamps, about 600 lumens per foot and 75 per cent reflectance upper wall combine to create a brightness of about 200 footlamberts just above the cove.

of the other forms of wall lighting. Lighted cornices are often considered more dramatic since their totally downward distribution places greater emphasis on the wall. Unless there is some light on the ceiling from other sources, the brightness ratio between the cornice and the upper wall is higher than desirable. (However, because cornices usually extend the full length of a wall, and can be spaced a greater distance from it, they can provide more effective wall lighting than other linear elements.) Examples of the application of this lighting method, both as the sole means of general lighting and as a contributor to the general lighting are shown in Figs. 9, 38, 45 and 52. In Fig. 9, needed reduction of brightness ratio between the 70 per cent reflectance drapery and the otherwise dark area above is obtained by a very small scaled cove, using special reflectors and T-6 fluorescent lamps attached to the lower edge of the cornice. Other less commonly used ceiling-attached or re-

cessed luminaires having reflectors carefully designed for wall illumination have specialized application[10] especially when more variable or more even brightness patterns on the wall are desired.

5.2.4—*Lighted Coves*—Suitably scaled and detailed moldings of a variety of materials mounted on upper side walls serve to conceal linear sources for indirect lighting. High-reflectance ceilings are essential; metallic finishes or very rough or swirl plaster should be avoided. Low efficiencies (*approximately half as effective as wall lighting*) and high costs and maintenance requirements make coves less generally applicable than types of general-lighting luminaires which provide both direct and indirect lighting. With lower ceilings, desirable cove lighting effects[32] are difficult to obtain unless the cove can, with architectural appropriateness, be 12 or more inches below the ceiling, Fig. 61. Lamp placement in relation to top of cove and side wall is much the same as shown in Fig. 56, although the cove directs no light on the wall below it. Extruded plastic forms introduce the possibility of luminous coves but provide only a negligible amount of downward light. Coves may be used on four walls in medium-sized nearly square rooms, but in the more typical rectangular rooms, and in large ones, are generally more pleasing if used only on the two long walls. (See Fig. 62.) Cove lighting alone tends to be monotonous unless vertical illumination is introduced for variation in wall-brightness pattern. A cove is particularly useful to complement ceiling-recessed direct lighting. See Fig. 62. Specialized cove design as well as other forms of general and local lighting have been discussed and more profusely illustrated elsewhere.[10]

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28. Ripley, D. L.: "Basis for the Selection of Values Used in the Lighting Performance Recommendations for Portable and Installed Luminaires," ILLUMINATING ENGINEERING, Vol. XLII, No. 5, p. 563 (May 1947).
29. Page, Aileen M.: "Structural Lighting in a Modern Home," ILLUMINATING ENGINEERING, Vol. XLVII, No. 10, p. 553 (October 1952).
30. Leighton, Kaye A.: "Pre-Plan, Pre-Wire to Protect Your Buyer," *Practical Builder* (December 1952).
31. Moon, Parry: "The New Approach to Room Lighting," ILLUMINATING ENGINEERING, Vol. XLIV, No. 4, p. 221 (April 1949); Moon, Parry, and Spencer, D. E.: "How to Design Your Luminous Ceilings," ILLUMINATING ENGINEERING, Vol. XLVI, No. 6, p. 295 (June 1951); Potter, Wentworth M., and Oetting, R. L.: "Design and Illumination Characteristics of Louver and Louverall Systems," ILLUMINATING ENGINEERING, Vol. XLIV, Nos. 1 and 6, pp. 16 and 341 (January and June, 1949); Cutler, C. M., and Amick, C. L.: "Some Architectural and Engineering Considerations of Louverall Lighting," *Progressive Architecture* (December 1948).
32. Brown, L. C., and Jones, J. R.: "Engineering Aspects of Cove Lighting," ILLUMINATING ENGINEERING, Vol. XLIV, No. 4, p. 233 (April 1949).
33. Marshall, M. V.: "The Use of Eye Glasses Among Public School Pupils," *School and Society*, Vol. 53, p. 582 (1941).
34. Luckiesh, M.: *Light, Vision and Seeing*, Chapter II, D. Van Nostrand Co., Inc. (1944).
35. Wakefild, G. P.: "Control and Measure of Directional Flux at the Task," ILLUMINATING ENGINEERING, Vol. XLVIII, No. 3, p. 124 (March 1953).

This report of the Residence Lighting Committee will be reprinted later, including as a special insert a color chip chart. Also included in the reprint will be Appendices covering: Task Visibility, Condition of Eyesight, Light Sources, Types of Light Distribution and Lighting Maintenance.

Here and There with I.E.S. Members

The "faculty" of the Home Lighting Workshop held June 15 to 19 in San Francisco, included (l. to r.) W. T. Kennedy, Kennedy Electric Co.; Miss Kaye Leighton, General Electric; Miss Marguerite Fenner, Pacific Gas and Electric; Miss Myrtle Fahsbender, Westinghouse and Paul Schmidt, General Electric. A total of 101 enrolled for credit in the five-day course in home lighting.

Participants in the Connecticut Section's contest for "My Most Interesting Lighting Job" are shown here at the May meeting of the Section: L. to r. are: Hal Young, Co-Chairman; Joe Barney, Coordinator; Jack Calander, first prize winner; John Dougherty, Co-Chairman; Adam Heuslein, second prize winner and Cecil White, third prize winner in the competition.

Speakers and officers at the Annual Joint Dinner Meeting of the Southern California Section of I.E.S. and the Electrical Maintenance Engineer's Association of Southern California were: front row, H. E. Riggs, D. W. Prideaux, L. J. Rejda, Dr. Harry C. Jolliffe, L. D. Black; rear row, Bob Ford, Section Chairman R. E. Dahlin and Richard Rogers, who is President of E.M.E.A. The meeting was again a notable success with 279 persons in attendance.

DINNER MEETING of the Chicago Section officers at which the outgoing officers and Board of Managers explained the operations and functions to the incoming ones. Standing are: C. A. Basedow, J. R. Chambers, W. A. Weibel, R. R. Lusk, G. I. Stadeker; seated: A. P. Larson, C. W. Clarkson, E. H. Church, J. H. Pierce and R. J. Diefenthaler.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

New York City Awaits I.E.S. National Technical Conference

Within a very few weeks of press time for this issue, the gavel will come down for the opening session of the 1953 National Technical Conference. Where and When? September 14-17, Hotel Commodore, New York City.

The opening session of the Conference is one *all* members of I.E.S. want to hear, regardless of their differing interests in specific lighting fields. It is, in effect, a summation of the year's work of the Society — its officers, Sections and Chapters — committees and members. A report on the year's achievements, financial status and numerous phases of Society operation will be made by the General Secretary, Clarence C. Keller. I.E.S. President, Professor Everett M. Strong will give his President's Address at this session. The incoming president, A. Homer Manwaring will outline the Society's course for the coming year.

Another feature of the opening session will be the presentation, by President Strong, of white (Fellow Grade) lapel emblems to twelve newly-elected Fellows of I.E.S.

Papers

Papers covering a wide range of interest have been assembled for the 1953 Conference. Preprints of each of them will be on sale at the Conference (and by mail from Headquarters) for $2.00 a set.

Architects and Decorators will be especially interested in the papers presented Wednesday, and in the Daylighting Session Thursday. For *Vision Specialists* — the opening session on "Brightness Concept and Visual Mechanisms" as well as papers #6 and #7 Wednesday morning will be important. *Street Traffic and Safety Engineers* are particularly concerned with the Thursday morning session on Street Lighting. *Industrial Plant Managers* are interested in the subject of Paper #15 "Maintenance of Industrial Lighting."

Of special interest will be an important paper "The Brightness Concept and Visual Mechanism" given by the distinguished scientist from England, Dr. W. S. Stiles of the Department of Scientific and Industrial Research in the National Physical Laboratory. Dr. Stiles' paper will present details of some very interesting work in illumination and vision which has been done in England, in terms of interest to non-technical people as well as experts. This paper, presented under the auspices of the I.E.S. Research Fund, will be a highlight of the technical sessions.

A half-day session on residence lighting will be an especially attractive feature to many delegates. This session, scheduled for Thursday morning, September 17, will illustrate the theme of "Residence Lighting Forums in Action" by presenting one paper from each of the five Residence Lighting Forums now affiliated with Sections and Chapters of the Illuminating Engineering Society.

The South will be represented by two speakers: Mrs. May Love Gale of the Tennessee Valley Residence Lighting Forum, will have as her topic "Electrical Planning Includes Good Lighting," featuring a home now being build in Nashville which will have unusual facilities in the way of wiring and electrical equipment in general, and up-to-date lighting in particular. "Introducing Garden Lighting Fashions in Atlanta" will be the subject for Miss Emily Alexander of the Georgia Power Company and the Atlanta Residence Lighting Forum. Miss Alexander will describe a carefully planned permanent lighting installation which adds much to the homeowner's enjoyment of a beautiful garden. The lighting of this garden, and of several others in the vicinity, came about as a direct result of a meeting of the Atlanta Residence Lighting Forum on the subject of garden lighting.

Miss Virginia Skinner of the Long Island Lighting Company will represent the New York Residence Lighting Forum with a paper on "Practical Lighting Features in Long Island Homes." Her talk will describe two homes recently built by people particularly interested in lighting. The rather unusual lighting

Conference Planners

H. P. Steele
Chairman
National Technical Conference Committee

C. C. Keller
Chairman
Conference Executive Committee

G. J. Taylor
Vice-President
Northeastern Region

Marshall Waterman
Chairman
New York Section

L. E. Barbrow
Co-Chairman
Papers Committee

R. M. Zabel
Co-Chairman
Papers Committee

requirements growing from their individual activities and preferences, and the way in which these requirements were met, forms the basis of an interesting lighting story. All of the talks will be illustrated.

Miss Edith Buchholtz of the Westinghouse Lamp Division, Chairman of the national Committee on Residence Lighting Forums, will preside at the Session and will speak briefly on "The Role of Residence Lighting Forums in the Illuminating Engineering Society." Another feature of the meeting will be the presentation of the new edition of the Society's "Recommended Practice for Residence Lighting," revised for the first time since 1947. The Practice will be introduced by Miss Mary Webber of the General Electric Company, Chairman of the Residence Lighting Committee for the past three years, during which most of the work on the completely rewritten Practice was done. The Recommended Practice is the Society's official pronouncement on the subject, and contains much helpful and authoritative material for the practitioner or the serious student of home lighting. This session will be of special interest not only to homemakers and to people directly engaged in home lighting activities, but also to those in the affiliated fields of architecture, interest decoration, home furnishings, and home economics.

No one will want to miss the Progress Report, of course. Come early, Tuesday evening. It starts at 8 p.m. and experience other years indicates s.r.o. Ted Sargent is Chairman and will present this ever-interesting demonstration on what's new in lighting.

My Most Interesting Lighting Job Contest finals will be another popular session. Tuesday afternoon, two o'clock.

I.E.S. National Technical Conferences

September 14-17, 1953 — Hotel Commodore, New York
September 12-16, 1954 — Chalfonte-Haddon Hall, Atlantic City
September 12-16, 1955 — Statler Hotel, Cleveland
September 16-21, 1956 — Statler Hotel, Boston.

ENTERTAINMENT

The Conference Committee has been working all summer on a program of entertainment. And of course New York City is a natural.

A "Mixer" party, for instance, is scheduled for 5 p.m. Monday, September 14, strictly informal. Theatre tickets are being lined up by a hard-working committee. If you haven't already done so, send your check payable to Jack Hamilton, Theatre Ticket Committee, care of Society headquarters, and he will do his best even at this late date, for New York shows.

Sports in and around New York are well in the picture. Gene Beggs of Westinghouse is handling that department.

The President's Reception and Banquet will be a highlight, of course. Commodore Grand Ball Room, Thursday, September 17.

FOR THE LADIES

A get-together coffee hour will start this program off Monday morning. After that Fifth Avenue shopping, a free luncheon date, the "Mixer" in the evening. Organized trips will include a Television Broadcast, luncheon a la Paris, a boat trip around Manhattan Island, the United Nations, matinees. You think of it — New York has it.

REGISTER NOW

Next Year's Lighting Clinics Planned by Chicago Groups

All-day clinics on several aspects of lighting are now being developed by subcommittees of the joint sponsors, the Chicago Section I.E.S. and the Chicago Lighting Institute. The Lighting Education Committee Chairman C. F. Jensen, has designated the following topics and chairmen for clinics to be presented this fall and early next year:

Farm Lighting — E. C. Scott.
Home Lighting — O. A. Hill.
Maintenance of Lighting Systems — Eric Church.
Artificial Light in Photography — Clifton Hyland.
Store Lighting — M. J. Maiers.
School Lighting — P. D. Cornelisen.
Lighting Gasoline Filling Stations and Parking Lots — J. F. Herbenar.

Several of these chairmen have begun organizing subject material and lining up speakers for the all-day sessions.

Annual Summer Conference Held by Iowa Section

Regional V-P L. B. Paist was guest of honor at the Summer Conference of the Iowa Section, held June 12, at the Hotel Lafayette in Clinton, Iowa. After the meeting was opened by Section Chairman James H. Hull, Mr. Paist addressed the members.

The program which followed had these speakers and topics:

Industrial Fluorescent Lighting—B. S. Benson, Benjamin Electric Mfg. Co., Chicago.
New Uses for Mercury Lighting—N. E. Passman, Nepo Mfg. Co., Chicago.
Fluorescent Street Lighting—George Coleman, General Electric Co., Chicago.

A hospitality hour was sponsored by Crescent Electric Supply Co., Republic Electric Co., Westinghouse Electric Supply and the Interstate Power Co.

Dinner speaker was Mrs. Mary S. Stafford of Des Moines, who gave a report on the Regional Conference.

Credit for the fine program goes to Dick Holcombe of Dubuque and Leonard Rafferty of Clinton.

THOSE attending the Summer Conference of the Iowa Section.

GROUP attending the Southern Regional Conference.

Southern Regional Conference Held in Carolina Resort

Some years ago, the Georgia Section presented an attendance plaque to the Southern Region, to be competed for at the Regional Conference. They have done a good job ever since of winning it themselves. The host Chapter is not eligible, but the other Chapters traveled far, in goodly numbers to the Southern Regional Conference May 18 and 19. And no wonder. In addition to offering a fine program the Conference was held at the beautiful Sedgefield Inn, at Greensboro, North Carolina. Attendance was 130.

In addition to Southern hospitality and Southern scenery at the season's best, delegates enjoyed a technical program of a very high order. Some ten papers were presented during the several sessions, with three outstanding addresses in addition. A list of the papers and addresses included:

Monday, May 18, 1953

Morning Session — Sedgefield Inn

Presiding: Hamilton C. Corey

Chairman, Carolinas Section

Address of Welcome—Hon. Robert H. Frazier, Mayor, City of Greensboro, N. C. (Introduction by R. M. Johannesen)

Response—R. C. Paslay, Vice-President, Southern Region.

Address—Everett M. Strong, President, I.E.S.

"Progress in Home Lighting," E. W. Commery, General Electric Co., Cleveland, Ohio.

"Meeting the Need for Home Lighting Information," Mrs. Charlotte Creighton, Duke Power Co., Charlotte, N. C.

Luncheon

Main Dining Room, Sedgefield Inn

Presiding: M. E. Broom

Chairman, Mid-South Chapter

"Salute to Lighting Progress," T. C. Sargent, Sylvania Electric Products, Salem, Mass.

Afternoon Session — Sedgefield Inn

Presiding: Joe L. Booker

Chairman, Tennessee Valley Section

"Color and Illumination for Room Interiors," J. A. Meacham, Sherwin-Williams Company, Cleveland, Ohio.

"Color in Lighting," M. L. Harkey, General Electric Company, Charlotte, N. C.

Evening Session—Plantation Supper Club

Presiding: Roy A. Palmer

Director, I.E.S.

Banquet: Honoring President and Mrs. Strong.

Introduction of Guests.

Presentation of Attendance Cup to Winning Section.

Dancing.

ON THE terrace of the Sedgefield Inn are: Mrs. S. G. Hibben, Past President S. G. Hibben, incoming V-P G. E. Park, Mrs. Charlotte Creighton, Roy A. Palmer, President E. M. Strong.

ENJOYING the beautiful grounds of this Southern resort are: Regional V-P R. C. Paslay; I.E.S. Director Roy A. Palmer; H. J. Corey and G. E. Wilkinson, Georgia Section Chairman and Secretary.

OUTDOORS . . . bracket lanterns beside doorway . . . post lantern for drive . . . offer safety, protection, convenience.

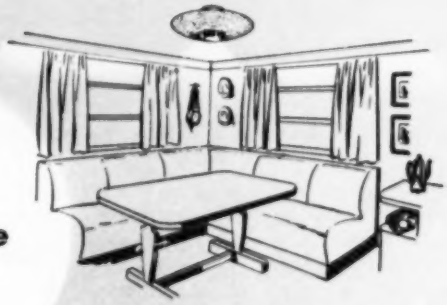
FOR HALLWAYS and bedroom "circulation areas" . . . light for safe passage (5 f. c.)

Indoors-Outdoors...

To light the home completely

VIRDEN meets new Recommended Practice

To help you provide Residence Lighting that fulfills the new Recommended Practice, Virden produces lighting equipment for the whole home—outdoors and indoors . . . tastefully designed, engineered for effective performance and built by volume methods for moderate prices . . . a combination that leads to this: *Virden value is GOOD VALUE!*



DINING SPOT . . . levels of light to fit uses . . casual dining, 5 f. c. . . . study, 40 f. c.

BATHROOM LIGHTING for shaving or make-up . . . 40 f. c. on face.

LIVING ROOM GLAMOUR . . . vertical suface lighting . . . walls, windows, draperies . . . with Virden Valances.

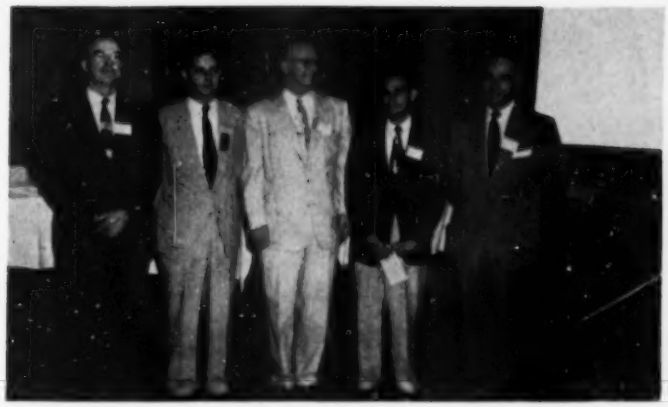
KITCHEN LIGHTING for comfort and efficiency . . . 10 f. c. general . . . 40 f. c.

WRITE for the Virden catalog . . . pictures the complete line in color. Just address your request to:

J. C. VIRDEN COMPANY

Cleveland 3, Ohio

WINNER of the My Most Interesting Lighting Job contest in the Southern Region is Mario Zervigon, here being presented with his check by incoming Regional V-P G. E. Park.



CONTESTANTS in the competition were: l. to r., S. B. LeCornu, Tennessee Valley Section; Earl J. Norris, Carolinas Section, runner-up; Harry T. Yopp, Georgia Section, second prize; Mario Zervigon, New Orleans, first; and F. G. Smith, proxy for Leigh Watkins III of the Mississippi Chapter.

Tuesday, May 19, 1953

Morning Session — Sedgefield Inn

Presiding: J. Dixon Mitchell

Chairman, Georgia Section, Atlanta, Ga.

"Lighting of the Greater Pittsburgh Airport," James Paul Warner, Electrical Engineer, Pittsburgh, Pa.

"Brightness Vs. Illumination for Luminous Ceilings," R. D. Burnham, The F. W. Wakefield Brass Co., Vermilion, Ohio.

"Economics in Classroom Lighting," R. L. Zahour, Westinghouse Electric Corporation, Bloomfield, N. J.

Luncheon

Main Dining Room, Sedgefield Inn

Presiding: R. C. Paslay

Vice-President, Southern Region, I.E.S.

"My Most Interesting Lighting Jobs"—(by Winners from Southern Sections and Chapters).

Report — I.E.S. Progress in the Southern Region, R. C. Paslay, Vice-President, Southern Region.

M. M. I. L. J.

Five Sections and Chapters competed for Regional representation in the finals, for the contest "My Most Interesting Lighting Job." Southern Region winner was Mario G. Zervigon, New Orleans Section. Mr. Zervigon will represent the Region in the National contest in New York in September. Second prize was won by Harry T. Yopp of the Georgia Section. Earl J. Norris of Carolinas Section received honorable mention.

Interest was keen in this contest. Indications are all Southern Sections and Chapters will compete with vigor in next year's contest.

ENTERTAINMENT

From the recreation standpoint, highlight of the Conference was without question the dinner dance at the Plantation Supper Club, just outside of Greensboro. No speeches—charming surroundings—good dinner—a wonderful party. President and Mrs. Strong were guests of honor at this session.

CREDITS

It's hard to say who deserves the greatest credit for a conference as successful as the Southern Regional. It takes many hands, but the members directing them were:

Conference Executive Committee

Regional Vice-President.....R. C. Paslay
Chairman, Carolinas Sec.....Hamilton C. Corey
Co-Chairman.....A. L. Ducker, Jr.
Co-Chairman.....J. H. Welch, Jr.
Secretary.....George Wilkinson
Treasurer.....Earl J. Norris

Committee Chairmen

Papers and Program.....Roy A. Palmer
Co-Chairman
G. E. Park
Co-Chairman
Registration and Reception.....Wesley Lewis
Entertainment.....Harry Phillips
Publicity and Attendance.....R. M. Johannesen
Finance.....Earl J. Norris
Ladies' Entertainment.....Mrs. Harry Phillips
Decorations and Lighting.....E. T. Greene
Transportation.....Willis B. Harris
Photograph Gallery —
Lighting Installation.....Jack Baldwin

Attendance at Southern Regional Conference

Alabama Chapter	1
Carolinas Section	62
Florida Chapter	2
Georgia Section	20
New Orleans Section	6
Southeast Florida Chapter	1
Tennessee Valley Section	4
Ladies	24
Non-Region members	10
Total	130

Alabama Chapter Holds Charter Night Meeting

The 62nd Chapter of the Society held its Charter Night, April 20th, when R. C. Paslay, Southern Regional V-P presented the charter of the Alabama Chapter to Chairman Walton T. Reeves. A total of 69 members and guests were on hand to see the presentation and that of the gavel, which was the gift of the Vancouver Island Chapter, next "youngest." The gavel was presented officially by J. Dixon Mitchell, Chairman of the Georgia Section, parent Section of the new Chapter. The gavel, incidentally, is

(Continued on page 14A)

GAVEL is presented to Walton T. Reeves, Chairman of the newly-formed Alabama Chapter, by J. Dixon Mitchell, Chairman of the parent Georgia Section. The gavel was the gift of the Vancouver Island Chapter.

congratulations to the ford motor company

on the beautiful new engineering and research center in Dearborn

Among the notable architectural features in this outstanding new building is the Smithcraft Area Illumination installation of overall lighting.

smithcraft area illumination is today's outstanding expression of an evolution in lighting. For centuries the only light source used by man emitted its illumination **from a point.** With the relatively recent development of **the linear source of light** in fluorescent lighting, higher levels of illumination have become economically practical and lighting has established itself as an important partner of the architect, owner and user.

Now advanced planners in architecture and illuminating engineering are thinking in terms of **area of light source.** Through advanced design and a brand new structural simplicity, Smithcraft Area Illumination has eliminated previous difficulties of installation and servicing. The system is actually one lighting "fixture" when installed. There is no superfluous multiplicity of supports to the ceiling and there are no complicated electrical service connections to clutter the plenum. And, most important of all, Smithcraft Area Illumination is economical, efficient and extremely easy to install.

SEND FOR FURTHER INFORMATION ON SMITHCRAFT AREA ILLUMINATION.

1. Lighting installation covers network of ducts and beams without interference with other services and with a minimum of supports to the ceiling.

2. The electrical element is completely installed and lamps are lighted. Men are installing framework for louvered shielding.

3. Louvers are being installed. Glass, plastic, lens . . .virtually any light diffusing medium may be specified for Smithcraft Area Illumination.

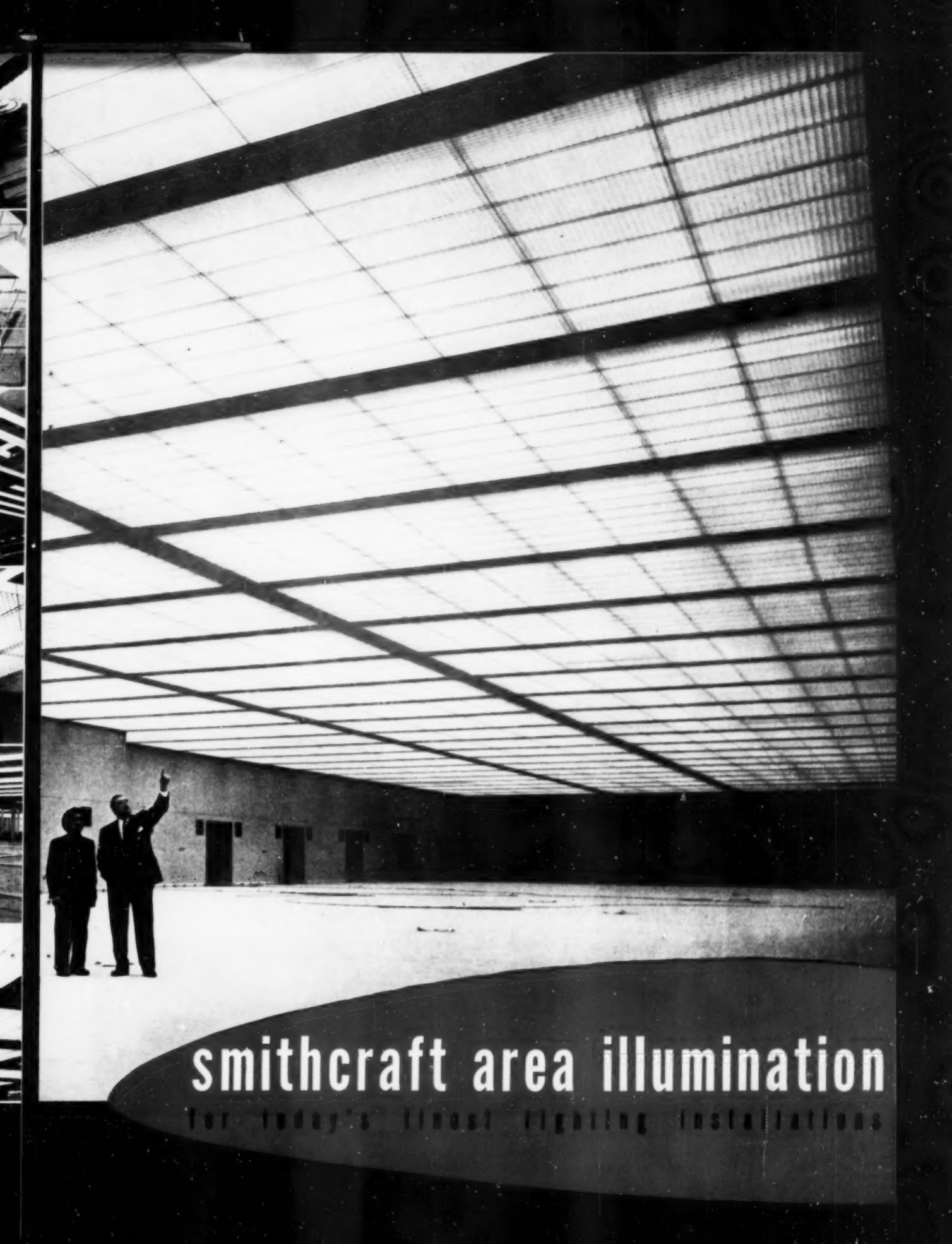
4. View between shielding and electrical element. Plenty of room for efficient lamp replacement. Acoustical metal pans are supported entirely by the lighting installation.

5. Lighting installation conforms to contour of the building. The system permits the architect a new freedom of choice as to size, pattern and shape, shielding, intensity and periphery.

There are three separate installations of Smithcraft Area Illumination in the Ford Engineering and Research Center with a combined area of more than 65,000 sq. ft. Intensities in the three areas are 112, 100, and 108 footcandles.

ARCHITECTS: Voorhees, Walker, Foley and Smith, New York
ELECTRICAL CONTRACTORS: Harlan Electric Company, Detroit
DISTRIBUTORS: General Electric Supply Company, Detroit

Smithcraft
LIGHTING DIVISION
CHELSEA 50, MASSACHUSETTS



smithcraft area illumination

for today's finest lighting installations

(Continued from page 11A)

of yew wood taken from a tree grown in the highland district of Vancouver Island, along the famous Malahat Drive. The wood used in the handle is of Arbutus, taken from a tree at Patricia Bay, British Columbia, overlooking Saanich Arm.

Guest speaker was President S. G. Hibben, whose meeting with the Alabama members last year was instrumental in the Chapter's formation. On their Charter Night, Mr. Hibben spoke on the history of I.E.S. and its accomplishments.

Aloys S. Shook, Secretary-Treasurer of the Chapter, presented to Chairman Reeves, a certificate of appreciation for the work done in bringing success to the formation of the Chapter.

Twelve Members Elected To Fellow Grade

Twelve members of the I.E.S. were elected to the Society's highest grade of Fellow by letter ballot of Council reported to the Council Executive Committee July 2. The elections, on recommendation of the Board of Fellows, were for:

George R. Baumgartner, Cleveland Section, Illuminating Engineer in Charge of Fixture Manufacturing Service, General Electric Company, Cleveland.

Gillson W. Beals, Connecticut Section, Chief Engineer, Illuminating Division, The Miller Company, Meriden, Conn.

Ralph M. Evans, Rochester Section, Superintendent, Color Control Division, Eastman Kodak Company, Rochester.

Glenn A. Fry, Ohio Valley Section, Director, School of Optometry, Ohio State University, Columbus, Ohio.

Sylvester K. Guth, Cleveland Section, In Charge of Lighting Research, General Electric Company, Lamp Division, Cleveland.

William H. Kahler, Cleveland Section, Manager, Engineering Section, Westinghouse Electric Corp., Commercial and Industrial Lighting, Cleveland.

H. J. Cory Pearson, Indiana Chapter, Chief, Lighting Branch, Airport Division, Department of Commerce, Civil Aeronautics Administration, Indianapolis, Indiana.

Wentworth M. Potter, Cleveland Section, Illuminating Engineer, in charge of Lighting Facilities Laboratory, General Electric Company Lamp Division, Cleveland.

Ernest H. Salter, New York Section, Research Engineer and Manager, Services to Lamp Manufacturers, Electrical Testing Laboratories, New York, N. Y.

George E. Shoemaker, Philadelphia Section, Senior Lighting Application Engineer, Philadelphia Electric Company, Philadelphia.

George J. Taylor, New York Section, Eastern Sales Manager, Day-Brite Lighting, Inc., New York, N. Y.

Carl W. Zersen, Chicago Section, Manager Director, Chicago Lighting Institute, Chicago, Ill.

Little Rock Group Has Active Year

The Little Rock Study Club of I.E.S. has just completed a "Chapter-size" year. Four big meetings were well attended and I.E.S. has been well represented in numerous local projects.

One instance of the respectful recognition of I.E.S. in Little Rock is the invitation from the State Health and Education Department to have a Society representative on the Department's Sight Conservation Committee. John S. Williams, Study Club Chairman, will represent I.E.S. on this committee.

Four meetings during the year drew large attendance, and further stimulated I.E.S. affairs in the territory.

NSPE Acts on Unity

Too many unresolved problems is the reason given by the National Society of Professional Engineers' Board of Directors for failing to accept, at this time, the Engineers Joint Council's invitation for the Society to join that group. The Board called for representatives of NSPE to offer to meet, as soon as possible, with representatives of EJC to discuss new approaches to unity of the engineering profession. NSPE President, John D. Coleman, pointed out that an early meeting is desirable in view of NSPE's next Board

(Continued on page 17A)

New Fellows

G. R. Baumgartner

G. W. Beals

R. M. Evans

G. A. Fry

S. K. Guth

W. H. Kahler

H. J. C. Pearson

W. M. Potter

E. H. Salter

G. E. Shoemaker

G. J. Taylor

C. W. Zersen

Corner units are PYREX brand Lenslites. Available round and square in wide-angle and concentrating patterns for controlling incandescent lights. Exceptionally resistant to heat. Intermediate units are Alba-Lite Pattern No. 66. Available flat or curved in three patterns, smooth, fluted and pebbled. Lengths 48", 24", 12".

Photo: Courtesy Grand Rapids Store Equipment Co.

Installation: The Fair—Evergreen, Evergreen Park, Illinois

Architect: Holabird, Root & Burgee

Lighting Design: Mr. I. Robert Palm, Professional Engineer for The Fair Department Stores

Fixture Manufacturer: Solar Light Manufacturing Co.

Electrical Contractor: Emerson-Comstock Company, Inc.

The *right* lightingware puts *appeal* in apparel

Architects and builders of the Fair-Evergreen, Evergreen Park, Ill., faced two problems common to department stores the world over:

1. How to make the store inviting to customers?
2. How to show merchandise at its sales-appealing best?

The photo shows how various types of CORNING engineered lighting glassware helped solve these problems in a large area with average room conditions, including taupe carpeting with a 40 to 50% reflection factor. The lighting plan is unobtrusive, but it has design and unity. It consists of 14-foot squares made up of troffers 12" wide in continuous rows plus corner units 12" square.

Alba-Lite panels afford comfortable, over-all lighting

Inviting, over-all lighting effects are provided by Alba-Lite Pattern No. 66 bottom panels in the fluorescent troffers. Illumination levels vary between 45 F.C. and 50 F.C. with no dark areas.

Merchandise looks its best because Alba-Lite transmits true color from the light source. Fixture efficiency is high, yet panel brightness is low. Smooth surface of the glass assures easy cleaning. And at no time can it warp, fade or discolor.

Lenslites direct light on columns

Corner units are 12" square, wide-angle PYREX brand Lenslites. These offset 100-watt incandescent light beams and direct them toward the columns.

Wide-angle Lenslites may be used without offsetting the beam to give a soft over-all effect. Or you can use concentrating Lenslites to spotlight merchandise.

This merely gives you an idea of the modern, efficient light transmission and architectural design flexibility that CORNING engineered lighting glassware can give you. To get the complete story, send for Bulletin LS-32 and the photometric data sheets. Write or mail the coupon for this information.

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Corning means research in Glass

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Please send me your Catalog LS-32, "CORNING Brand Glassware for Fluorescent Lighting."

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Globe's name on industrial lighting units has always meant conformance with maximum specification and performance standards. Authorized use of the RLM label by Globe, now gives added assurance of: better performance, long life, sustained lighting efficiency and economical operation. Write for details on Globe's "5100" series, RLM industrial lighting units.

Globe Lighting Products Inc., Los Angeles: 2121 South Main Street
New York: 1710 Flushing Ave., Brooklyn

(*Continued from page 14A*)

Meeting to be held in November at which time the NSPE Board will further consider the question. The decision was made at NSPE's 19th Annual Meeting in Daytona Beach, Florida, June 18-20, 1953.

The Board, representing NSPE's 39 state societies, pointed out that unity of the profession is of paramount importance, but that the means for accomplishing it, needed further clarification. Board members stated that more information was necessary concerning such items as individual membership in the enlarged EJC; the function of NSPE as a member; the degree to which NSPE's programs would be affected; and similar matters of concern.

The recently reorganized EJC has extended invitations to several engineering societies, one of which was NSPE, to become members. The Society has had an observer at meetings of the proposed unity group since that time.

The enlarged EJC is a direct result of deliberations of an Exploratory Group for Unity of the Engineering Profession. The Group was composed of representatives from leading engineering societies, and considered four plans that could lead to greater unity. The Group, of which NSPE was a member, met over a period of about two years.

Don't Slap — Use the Right Color Lamp

Nocturnal flying insects are colorblind, in the human sense of the word. Their eyes are sensitive only to blue light, and to the near ultraviolet rays, which are almost invisible to humans.

This knowledge, according to J. P. Ditchman, General Electric Co. engineer, makes it simple to keep insects away, or to attract them, during summer evenings. To attract bugs you use a blue or ultraviolet light, and to refrain from attracting them use a light bulb which produces neither of these. However, the appearance of a lamp can be misleading, according to Mr. Ditchman. Most lamps, whatever their predominant color, also produce a mixture which includes some blue.

From the standpoint of being unnoticed by insects, red or orange lights would be as effective as the yellow commonly used as anti-bug lamps. But yellow is more pleasing to the human eye.

Among fluorescent lamps, the gold ones alone absorb the insect attracting wavelengths, according to Mr. Ditchman. Other fluorescent lamps are attractive to bugs, and blue and black light fluores-

(*Continued on page 20A*)

LIGHTING CALENDAR

Society Events

September 14-17, 1953—Illuminating Engineering Society, National Technical Conference, Commodore Hotel, New York, N. Y.

September 12-16, 1954—Illuminating Engineering Society, National Technical Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.

Industry Events

August 5-8, 1953—International Association of Electrical Leagues, 18th Conference, Fairmont Hotel, San Francisco, Calif.

September 1-4, 1953 — American Institute of Electrical Engineers, Pacific General Meeting, Hotel Vancouver, Vancouver, B. C., Canada.

September 21-26, 1953 — International Association of Electrical Inspectors, 25th Jubilee Meeting, Edgewater Beach Hotel, Chicago, Ill.

September 23-25, 1953—Canadian Electrical Manufacturers Association, Annual Meeting, General Brock Hotel, Niagara Falls, Ont.

September 29 - October 2, 1953 — National Electrical Industries Show, 69th Regiment Armory, New York, N. Y.

October 5-8, 1953—International Municipal Signal Association, Neil House, Columbus, Ohio.

October 5-9, 1953—Society of Motion Picture and Television Engineers, Semi-Annual Convention, Hotel Statler, New York, N. Y.

October 6-8, 1953 — Fourth Industrial Electric Exposition, William Penn Hotel, Pittsburgh, Pa.

October 14-17, 1953—Joint Meeting of the American Society for Engineering Education and Educational Council for Professional Development, Hotel Statler, New York, N. Y.

October 19-21, 1953 — American Standards Association, 35th Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

October 19-23, 1953—National Safety Council, 41st National Safety Congress & Exposition, Chicago, Ill.

November 2-6, 1953—American Institute of Electrical Engineers, Fall General Meeting, Muehlebach Hotel, Kansas City, Mo.

November 9-12, 1953 — National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

November 16-20, 1953 — National Electrical Contractors Association, Miami Beach, Fla.

November 29 - December 4, 1953 — The American Society of Mechanical Engineers, Annual Meeting, Statler Hotel, New York, N. Y.

December 2-4, 1953—National Association of Manufacturers, Annual Convention, Waldorf-Astoria Hotel, New York, N. Y.

January 11-14, 1954—National Rural Electric Cooperative Association, National Convention, Miami, Florida.

January 18-22, 1954 — American Institute of Electrical Engineers, Winter General Meeting, New York, N. Y.

March 8-11, 1954—National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

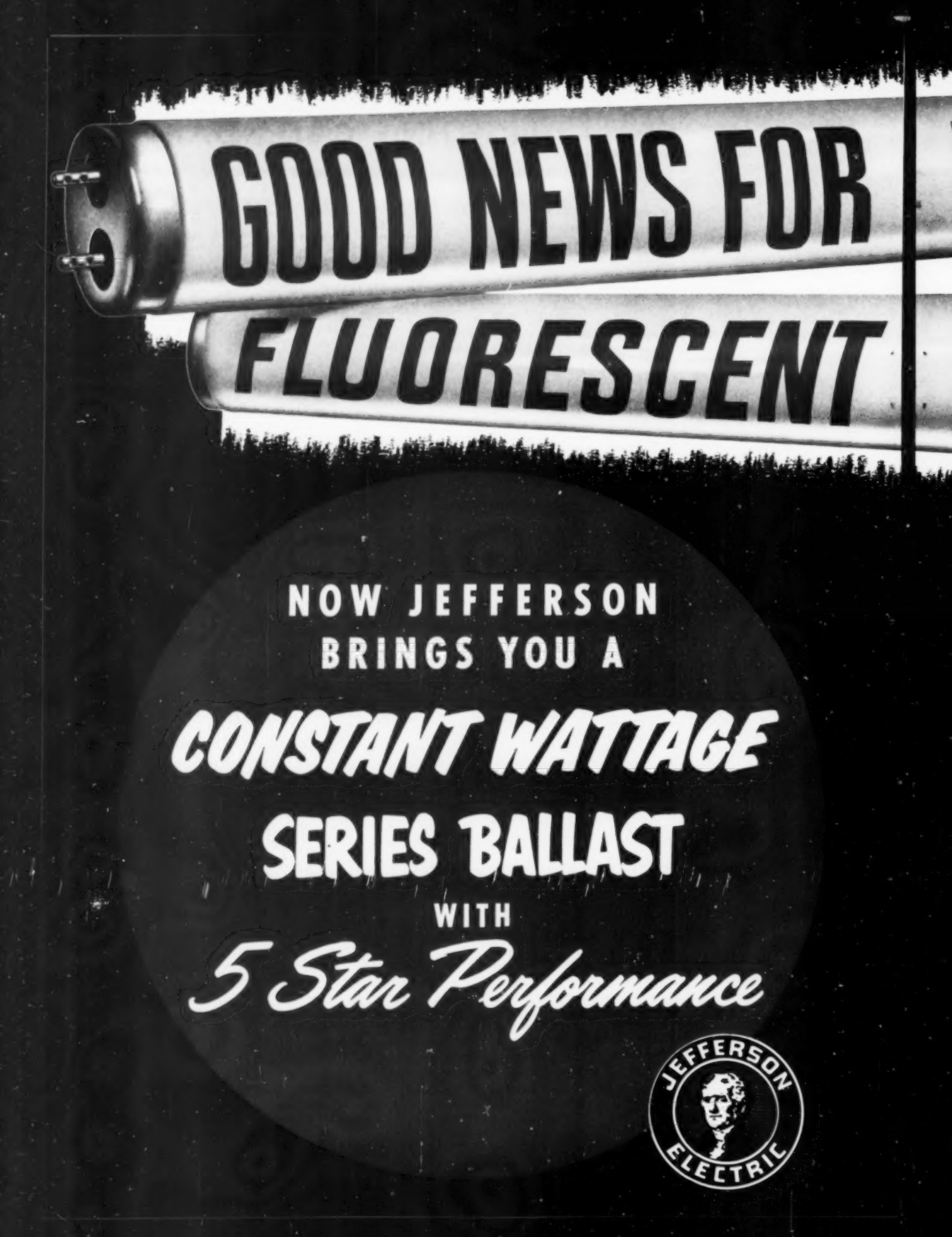
May 3-7, 1954—Society of Motion Picture and Television Engineers, Semi-Annual Convention, Hotel Statler, Washington, D. C.

May 13-14, 1954—Public Utilities Advertising Association, National Convention, Hotel Statler, Boston, Mass.

June 6-11, 1954 — National Association of Electrical Distributors, 46th Annual Convention, Atlantic City, N. J.

June 21-25, 1954 — American Institute of Electrical Engineers, Summer General Meeting, Los Angeles, California.

MEMBERS of the Committee on Testing Procedures, meeting at Corning Glass Co., Corning, N. Y., May 27-28, 1953, inspect the work of the glass blower in the Glass Center. Left to right are: J. H. McCulloch, Robert Faucett, A. W. Weeks, A. E. Krawcek, Kurt Franck, John A. Losh, R. D. Bradley, J. E. Bock, R. P. Teele, William Dorman, Chairman G. A. Horton, A. P. Larson, C. L. Crouch, Phelps Meaker, W. F. Nottelman, Thomas Leister, P. B. Clark. The Committee, with George Horton, Chairman carried on intensive checking of latest draft of the proposed I.E.S. Guide on Photometry. The Brightness Sub-Committee, under James McCulloch, also had a session on brightness measurements.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NOW JEFFERSON
BRINGS YOU A
CONSTANT WATTAGE
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Constant Light Output

Jefferson's new ballast combines the outstanding advantages of constant wattage with the money-saving features of the series rapid start circuit. This gives you positive and quick starts, ideal lamp operation, and constant light output—despite line voltage variations of as much as 20%.

100% Lumen Output

Superiority of design makes sure that you get an average of 100% lumen output — even with the normal voltage variations encountered. This means greater customer satisfaction.

Cool Operating

Great efficiency and low watt loss assures you of a unit that meets *all* current specifications regarding this type unit. This is attested to by the Electrical Testing Laboratories' Certification.

Completely Safe

With the Jefferson ballast a series circuit is safely *isolated*. This eliminates shock hazard and permits safe lamp replacement when the current is on.

Easier Wiring

Rapid Start lamps fit conventional bi-pin holders. There are no starters to wire. And, the new Jefferson unit fits standard rapid start fixtures — no new fixture tooling to worry about.

Jefferson 254-621 ballast is listed by Underwriters' Laboratories.

JEFFERSON ELECTRIC COMPANY
BELLWOOD, ILLINOIS

Catalog No. 254-621
Write For Bulletin 532-11

Jefferson Ballasts

(Continued from page 17A)

cent have so much appeal that they are used in insect traps.

To minimize the annoyance and damage caused by flying insects during summer evenings, this advice is offered by the G-E engineer:

(1) Use yellow incandescent lamps on porches and entrances.

(2) Illuminate outdoor picnic tables with hard-glass spot or flood lamps mounted at a distance, so that bugs, attracted to the light source will drop to the ground instead of on tables and people.

(3) Use yellow lamps in the immediate area, and place blue or white lamps, or a black light insect trap, at a distance from where people congregate.

OBITUARY

Davis H. Tuck

Davis H. Tuck, Fellow and Member Emeritus of the Illuminating Engineering Society, passed away July 5 at his home in Redding Ridge, Connecticut, at the age of 65.

Mr. Tuck, who joined the Society in 1917, had been associated with the Holophane Company from that date until the time of his death. He was a Director of the company and Chief Electrical Engineer. For the past two years, since his retirement, he had been acting as Consultant for Holophane.

In recognition of his many contributions in the field of illuminating engineering, Mr. Tuck was raised to the grade of Fellow of the Society in 1948. He had served on many committees, with a main interest in the field of industrial lighting equipment and measuring instruments, for which he had been issued many patents. He had contributed numerous papers on these subjects for technical and trade journals.

In 1951, Mr. Tuck was made a Member Emeritus of the Society upon his retirement from active service.

ABOUT PEOPLE

Darwin Curtis, formerly Chairman of the Board, was elected President and Treasurer of Curtis Lighting, Inc., at a special meeting of the Board of Directors, necessitated by the death of **Melvin C. Wilt. Ward Harrison**, former Director of Engineering for the General Electric Co. Lamp Division, was elected Chairman of the Board, **George Gilleard**, formerly Assistant Chief Engineer, was named Secretary. Other officers of the company are: **G. T. Morrow**, Vice-President, Sales; **W. V. C. Foulks**, Vice-President, Engineering; and **A. W. Carlson**, Vice-President, Production.

The F. W. Wakefield Brass Company, Vermilion, Ohio, has announced to the Canadian lighting profession and trade the formation of Wakefield Lighting Limited, with factory and offices in London, Ont., and sales offices in Toronto. This plant will take up the production of Wakefield equipment formerly assembled from parts at the Royce Avenue Works of the Canadian General Electric Co., Ltd. Chairman of the Board of the new company is **A. F. Wakefield**, President of the F. W. Wakefield Brass Co., Past President of I.E.S. and current chairman of the I.E.S. Research Fund. President of the Canadian Company is **T. D. Wakefield**, Vice-dent of F. W. Wakefield Brass Co. and currently a member of the executive committee of the U. S. National Committee of the International Commission on Illumination. Vice-President is **Ralph A. Yates**, in charge of administration and sales activities. **John D. Harrison**, of the law firm, Harrison and Elwood, London, Ont., serves as Secretary. A completely new and modern plant is under construction on Wellington Road, London.

The election of **Elgin E. Robertson**, president, Elgin B. Robertson Co., Dallas, Texas, as president of the American Institute of Electrical Engineers, was announced at the Summer General Meeting of the Institute at the Chalfonte-Haddon Hall Hotel, June 15. Mr. Robertson will take office August 1, and will serve until August 1954.

D. E. Inman, veteran executive of the Westinghouse Electric Corp., has been appointed engineering manager of general industrial products. In his new position, he will exercise staff supervision and coordinate the engineering activities of the general industrial products divisions.

John H. Ronayne, former manager of the Better Light-Better Sight Bureau, has been named to the advertising staff of General Electric's Lamp Division, in Cleveland. In his new capacity he will be engaged in a variety of lamp and lighting promotional activities. From 1940 to 1949, Mr. Ronayne had been engaged in editorial work for the Edison Electric Institute, in New York City. Succeeding Mr. Ronayne at Better Light-Better Sight is **Edward A. Campbell.**

The Board of Directors of the Public Service Co. of Colorado, at its June 24 meeting, elected a new Secretary and a new Treasurer to become effective September 1. Due to the retirement of the present Treasurer, **D. G. Guiney**, after 45 years of service, **W. D. Virtue**, a vice-president of the company, was elected to succeed him. **H. A. Mitchell**, now an Assistant Secretary was elected to the post of Secretary.

Herbert A. Anderson, formerly Chief Incandescent Engineer for Duro-Test Corp., has been appointed to the newly created post of Commercial Engineer for that company. This appointment is part of a reorganization in sales training, promotion and advertising. He is succeeded by **Donald H. Gardner**, who has resigned from the National Bureau of Standards to accept the position as Chief Incandescent Engineer with Duro-Test.

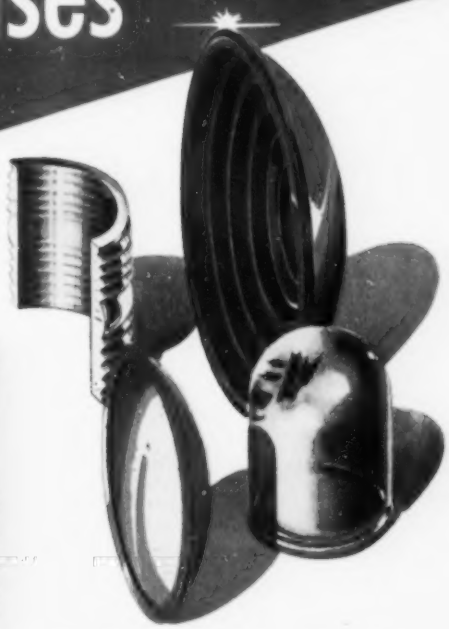
Four plant managers have been appointed to new positions with the General Electric Co., Lamp Division. **T. M. Wallace**, of the Lexington, Ky., Lamp Works is being transferred to the Lamp Manufacturing Department at Cleveland headquarters. **A. D. Dixon**, manager of the Warren, Ohio, plant assumes the post vacated at Lexington by Mr. Wallace. **T. A. Glidden**, manager of Bucyrus, Ohio, plant fills the position vacated by Dixon in Warren. **J. W. Wright** has been named manager of the Bucyrus Lamp Works, succeeding Glidden.

(Continued on page 26A)

A listing of lighting installations to visit in New York City — while you are in the city for the Conference — is on pages 23A and 24A, this issue.

New light on lenses

and other glass products . . .



This new brochure now available . . . Send for a copy.

New useful data on Kopp engineered glass products is given in the brochure shown above. It describes a wide variety of lenses, color filters, cover glasses, globes and other items designed by Kopp engineers, and shows the manufacturing processes by which Kopp products are made.

Each of the Kopp products described has been designed to fulfill the requirements of some specific application. A study of the brochure shows the possibilities of expertly designed and carefully made glass parts in many fields and applications.

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Please send a copy of KOPP ENGINEERED GLASS (Bulletin K-353) to:

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NO MORE GUESSWORK IN BRIGHTNESS READINGS

New *SPECTRA* instrument actually *eliminates human factors.*
Gives brightness readings automatically; instantaneously

NEW *SPECTRA* BRIGHTNESS SPOT METER

Now Illuminating Engineers and others whose work requires fast, accurate lighting calculations can have a new, highly dependable instrument absolutely free from human estimate . . . light, compact and easily portable . . . adaptable for all types of work indoors and outdoors.

Developed from Photo Research's long experience in design, manufacture and use of exposure meters, densitometers, color temperature meters, filters and other precision photographic instruments, the SPECTRA BRIGHTNESS SPOT METER is the first such commercial illumination measuring instrument. By automatically measuring the brightness of a small spot from a remote location to the I.C.I. Standard luminosity curve, this meter saves valuable time and provides direct reading instant accuracy.

SPECIAL FEATURES OF *SPECTRA* BRIGHTNESS SPOT METER

- Direct Reading in Footlamberts
- Small Angle
- Extreme Range of Sensitivity . . . from 0.1 to 1000000 ftls in six ranges
- Locking Microammeter . . . reading retained until button depressed
- Self-Contained . . . requires no external power or wiring. External, optional
- Completely Portable . . . small size and light weight
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- Dependability . . . battery replacement only maintenance
- Focusing . . . from 4' to ∞ by rotating lens barrel . . . supplementary lens available to focus 1/10" at 2"

Write for illustrated brochure giving complete details of these special features, specifications of SPECTRA BRIGHTNESS SPOT METER, and various attachments for special purposes.

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Installations To See Around

NEW YORK CITY

Classification	Installation	Address*	Interesting Features
Art Gallery	Associated American Artists Galleries	711 Fifth Ave.	Combination incandescent and fluorescent
Banks	Franklin Savings Bank	8th Ave. & 42nd St.	High level downlighting tied in with decoration and architecture
	Irving Trust Co.	380 Madison Ave.	4-foot diameter concave plastic units
	Federal Reserve Bank	33 Liberty St.	Semi-indirect plastic shielded units
	Manhattan Savings Bank	Madison Ave. & 48th St.	Recessed fluorescent and incandescent
	Howard Savings Bank	768 Broad St. Newark, N. J.	High bay (50-foot) slimline lighting
	Bank of New York	48 Wall St.	Surface-mounted—louver-shielded
	Bankers Trust Co.	57th St. & Park Ave. Radio City	Recessed incandescent with controlled cove lighting
	Chase National Bank	45th St. & Madison Ave.	Modern incandescent approach
	Manufacturers Trust Co.	177 Montague St. Brooklyn	High level downlighting and specially converted chandeliers for indirect and decorative effect
Beauty Salon	R. H. Macy & Co.	34th St. & 6th Ave.	Recessed troffers with accent lighting
Bus Terminal	Port of New York Authority	8th Ave. & 41st St.	Recessed troffers in geometrical patterns
Drafting Rooms	Gibbs & Hill	461 8th Ave.	Semi-indirect—100 ft-c
	American Car & Foundry	30 Church St.	Two-lamp 45-watt 45-degree louvered units on 5-foot centers
	Otis Elevator Co.	260 11th Ave.	Luminous indirect with clear plastic top
	Shreve Lamb & Harmon	11 East 44th St.	Continuous row — pendent fluorescent
Churches	Fifth Ave. Presbyterian	55th St. & 5th Ave.	Blend of decorative and utilitarian lighting with pre-set dimmer control
	St. Ephrems R. C. Church	75th St. & Ft. Hamilton Parkway, Brooklyn	Downlighting plus controlled period lanterns
College	Manhattanville College of the Sacred Heart	Purchase, N. Y.	Custom designed for modern architecture
Flood Lighting	Con Edison Substation	7th Ave. & 19th St.	Special unit designed to light building and sidewalk
Hotel	Hotel Plaza, Persian Room	59th St. & 5th Ave.	Elaborate installation with inconspicuous units
Industrial	New York Times Composing Room	Times Square	Shielded industrial
Laboratory	Electrical Testing Laboratories, Inc.	2 East End Ave.	5-foot low surface brightness units
Libraries	Academy of Medicine	103rd St. & 5th Ave.	Adaptation of lighting to ornate ceiling
	New York Public Library	42nd St. & 5th Ave.	Surface luminaire louver controlled
Lobbies	Office Building	76 William St.	Louvered ceiling
	Office Building	115 Broadway	Cove lighting
	United Nations	1st Ave. & 43rd St.	Adjustable recessed incandescent
	Office Building	25 W. 45th St.	Louvered ceiling
	American Airlines Ticket Office	Rockefeller Plaza 49th St.	Luminous ceiling
	Office Building	385 Madison Ave.	Specially designed ceiling with color-changing effects in a honey-comb ceiling
Museum	Chase Bank, Money Museum	15 Broad St.	Continuous runs semi-indirect
Offices	I.E.S. Headquarters	1860 Broadway	12 different installations from direct lighting to luminous ceilings

*All installations are in Manhattan, unless otherwise marked.

(over)

Classification	Installation	Address*	Interesting Features
Offices (cont.)	Sinclair Oil Bldg.	600 5th Ave.	Molded plastic shielded units
	Con Edison (Various Floors)	4 Irving Place	Louvered fixtures further shielded by architectural elements
	Shell Oil Co.	30 Rockefeller Plaza	Low surface brightness units
	Lever House	390 Park Ave.	Recessed troffers with low brightness lens
	United Nations	1st Ave. & 43rd St.	Troffer lighting
	American Asso. Insurance Co., General Offices	99 John St.	Fluorescent luminaires
	Marsh and McLennon	70 Pine St.	Deep aluminum troffers
	Board of Transportation	370 Jay St. Brooklyn	Suspended fixtures with low brightness lens
	Sperry & Hutchinson Co.	114 5th Ave.	8-foot slimline coffers
	Bigelow Sanford	140 Madison Ave.	Low brightness troffer
	Graybar Electric Co.	21-15 Bridge Plaza No. Long Island City	Parabolic Alzak aluminum recessed troffer
	McGraw-Hill Publishing Co.	330 W. 42nd St.	Suspended all-metal slimline — 96 ft-c maintained
	International General Electric Co.—Medical Products Division	205 E. 42nd St.	Direct-indirect continuous fluorescent
	Chrysler Bldg. Annex—32 Floors (For tours see Mr. C. Lawrence—Bldg. Mgr.)	42nd St. & 3rd Ave.	Standard units furnished by building
	Fawcett Publications, Inc. (For viewing, see Mrs. Davidson)	67 W. 44th St.	Luminous ceiling and various types of lighting
	Aluminum Co. of America (See Mr. Jackson for viewing)	230 Park Ave.	General diffuse
	First National Bank of Chicago (N. Y. Branch) (See Mr. Schluter for viewing)	48 Wall St.	Recessed low brightness — 5 foot troffers
Radio Studio	Studio "A" WQXR— Times Bldg. 9th Floor	Times Square	Continuous incandescent lens lighting with offset distribution
Restaurants	Longley's Restaurant	6th Ave — 50th & 51st Sts.	Coffers and mural lighting
	The Brass Rail Restaurants	100 Park Ave. 521 5th Ave.	Period wall brackets and chandeliers
Showrooms Rug	Bigelow Sanford	140 Madison Ave.	Incandescent and fluorescent downlighting
Automotive	Flatbush Pontiac Co.	1330 Flatbush Ave. Brooklyn	Luminous ceiling
Textile	Cohn-Hall-Marks	36th St. & Madison Ave.	6 x 6 plastic shielded fixtures
	United Merchants & Manufacturers	1407 Broadway	Luminous ceiling and troffers
Specialty Lighting	Brooklyn-Battery Tunnel		Continuous line lighting with flexible brightness control
	Liberty Ave., Sutter, Van Sielyn Ave. & Euclid Ave. Stations of Independent Subway on Fulton St. Line.		Subway lighting
Stores	Gunther Jaeckel	57th St. & Madison Ave.	
	Sugar & Spice Bakery	8th Ave. Subway 42nd St.	Louvered ceiling
	Gimbel Bros.—Main Floor	Broadway & 32nd St.	Combination incandescent and fluorescent luminaires
	Rogers Peet & Co.	600 5th Ave.	Low brightness downlighting
	Fanny Farmer	6th Ave. & 50th St.	Large area diffusing panel with prismatic control
	Bergdorf Goodman, Chinaware Dept.	58th St. & 5th Ave.	Adjustable recessed spots
	Lanes Dept. Store	14th St. & 5th Ave.	Combination fluorescent incandescent downlighting, valance lighting, etc.
	Winthrop Shoe Store	345 Madison Ave.	Plastic shielded diffusing units
	Raphan	1323 Kings Highway Brooklyn	High level general and display lighting for carpets and rugs. Incandescent, fluorescent and color used

Compiled by the New York Section, I.E.S.

A pattern of Skylike units using 300 w. lamps provides perfect lighting in The McDaniel's Store in Grand Rapids, Mich.

Skylike

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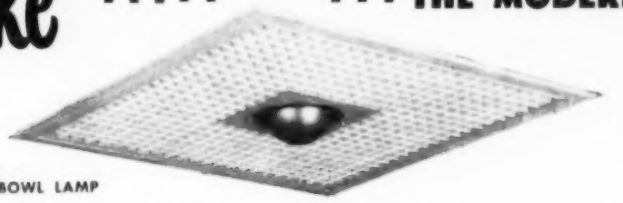

WITH THE SILVERED-BOWL LAMP

selected by leading
RETAIL STORES
SPECIALTY SHOPS
DEPARTMENT STORES

Today's modern merchandising in the stores of America demands modern surroundings. Redesigning the display and selling areas in all types of stores has been a prime problem of architects who, through their combined talents, have produced that high degree of effectiveness, appearance and utility that is the world's standard today.

And, in those plans, lighting is of vital importance. It must show merchandise in its true value; the unit must be architecturally correct and provide economical lighting. Above all it must be shielded from all critical angles of vision for comfortable seeing. That's why SKYLIKE is being selected for the majority of important store installations.

FOR COMPLETE DETAILS:

An 8 page booklet fully describing Skylike recessed and surface mounted units, its adaptability and ease of installation in new or remodeled applications is free for the asking. Just fill in, clip and mail this coupon.

SKYLIKE
A SILVRAY-ASSOCIATED COMPANY

SKYLIKE Lighting, Inc. **104 West Main St., Bound Brook, N. J.**

Gentlemen:

Please send me complete information on Silvray **SKYLIKE**

NAME_____

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RETIRING and incoming Chairmen of the New York Residence Lighting Forum are, at left, Edith Buchholtz, Westinghouse Electric Corp. and, at right, Winonah Murphy, Sylvania Electric Products.

(*Continued from page* 20A)

Howard E. Bahr, assistant director of public relations at Corning Glass Works, has been appointed director of displays and exhibits, and will direct the company's institutional and product display activity at national trade shows, sales conferences and all company offices and plants including the Hall of Science and Industry at the Glass Center in Corning, N. Y. Named as manager of public relations for the Corning office is **John T. Lanahan.**

George W. Douglas has been appointed Street Lighting Consultant for Corning Glass Works, with headquarters at Corning. Mr. Douglas was formerly the company's lighting sales representative for the Middle Atlantic District.

Stuart Goodwillie, formerly with Sylvania Electric Products, Inc., has joined Stewart, Dougall and Associates, Inc., management consultants, at 30 Rockefeller Plaza, New York City.

The **Max Gruber** Sales Co. has been organized to represent the Eastern Fixture Co., Boston and the J. A. Wilson Display Co., Buffalo, and Radiant Lighting Co., New York, among other lines.

After two years service with the Air Force at Grenier Air Force Base, New Hampshire, and Pepperrell Air Force Base, St. John's, Newfoundland, **R. S. Wissoker** has shed his Air Force Blue for civilian garb. With his release from service, he has returned to work with Chippindale Electric Co., New York representatives for Day-Brite Lighting Inc.

Jack A. Frost, Detroit electrical contractor, has just returned from the Far East where he investigated possibilities for electrical contractor service there. With Mr. Frost were **Fred Compton,** Detroit Edison Co., and a group of 42 prominent industrialists, members of the Detroit Board of Commerce, which sponsored the Far East Trade Tour. The month's trip was climaxed in Manila by a meeting with the President of the Republic of the Philippines. Of special interest to the group were Tokyo, where many major industrial constructions are underway, and the Philippine Islands, where an outstanding industrial potential was noted.

His Royal Highness, **The Duke of Edinburgh,** has accepted Honorary Membership in the Engineering Institute of Canada, it was announced by Ross L. Dobbin, president of the Institute. Recently His Royal Highness was president of the British Association for the Advancement of Science. His presidential address on the occasion of his induction into that office was published in Canada by the Engineering Institute in The Engineering Journal.

IT SEEMS TO ME

School Lighting — June I.E.

It seems to me that the recent school lighting issue of ILLUMINATING ENGINEERING, complete as it was, avoided one important consideration. If an elaborate daylighting installation is still unable to provide 30 footcandles on a dark day, is its construction justified, at least in the northern half of the United States?

The paper, "Correlation of Lighting Goals with School Building Design," does not give the interior illumination levels for dark days; neither does it say that the school types described are recommended only for southern climates. In "Daylighting Performance of a Pre-Tested School Design," Mr. Crouch does give illumination measurements for a dark, overcast day and finds levels ranging from 1.5 to 6.5 footcandles on the desk tops.

This means that the building, with its bilateral daylighting and louvers for the control of glare, will still need a full-size installation of electric lighting. Thus the comparison should be between a building having the elaborate daylighting system and one having just a "vision strip" of windows, both to have the same electrical installation.

For the former, the cost of installing and maintaining the extra glass and control devices, together with the additional heat loss through the glass, should be compared with the additional cost of electrical energy for operating the lighting system of the latter school through longer hours.

Perhaps the extra daylight would still win out, but it should be of interest to read the paper given by Richard F. Hammel and Gordon Moore at the 1953 Midwestern Regional Conference in Minneapolis. In "Daylight and the Schoolroom in Northern Climates," the authors uphold the opposite view, at least for the climates discussed. Also, those who went on the tour of new lighting installations in Minneapolis and St. Paul were shown an interesting new high school which has only vision strips and depends on the electrical system for working illumination. — WILLARD ALLPHIN, *Illumination Research, Sylvania Electric Products Inc., Salem, Mass.*

• • •

The June 1953 issue of ILLUMINATING ENGINEERING is one of the finest publications I have ever read concerning School Lighting. . . . I would very much like to present a copy of this issue to our School Board, but I refuse to part with my copy! Please send me an extra copy.

Thank you for your courtesy.—LOWELL D. GLATT, O.D., *Visual Consultant, Yonkers, N. Y.*

• • •

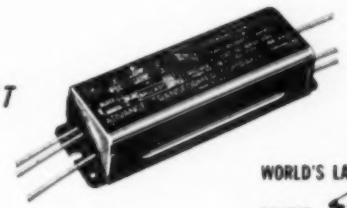
I have just finished going through the June issue of ILLUMINATING ENGINEERING which places particular emphasis on school lighting and it required considerable control on my part to maintain my blood pressure at its normal level. How a recognized publication of this type could completely ignore what is today regarded in leading communities as the outstanding contribution to school lighting is certainly beyond my power of comprehension. It may be a secret to you, your editorial staff and your advertising department. It is certainly no secret to all those other people who are only interested in selling that type of lighting which a great many school systems have concluded "is certainly not best for us." I am talking about Cold Cathode lighting. I think it is about time that an Engineering Society and a publication which represents them and substantially the entire lighting fraternity, finally realized that they are doing themselves immeasurable harm and are creating in the minds of a great

(*Continued on page* 28A)

Quiet...

Here Lies
Ballast Hum
Rest in Peace
Born: With Fluorescent Lighting
Died: A. D. 19-53 a
natural death through scientific research in the laboratories of
Advance Transformer Co.

The QUIET — LONG LIFE BALLAST



The WORLD'S LARGEST MANUFACTURER DEVOTED *Exclusively* TO THE PRODUCTION OF FLUORESCENT BALLASTS

ADVANCE TRANSFORMER CO.

The Best Ballast Buy

CABLE ADDRESS: ADTRANS

1122 W. CATALPA AVE., CHICAGO 40, ILL., U. S. A.

(Continued from page 26A)

many people doubts about their responsibility and desire to disseminate factual information on a more competitive basis.

I have followed for many years this effort on the part of the organized groups in lighting to keep the lid on cold cathode lighting and in the face of indisputable evidence to disseminate information which was neither factual nor desirable, and I cannot any longer sit here and watch this continued performance.

May I strongly suggest that a proper investigation by some fair minded individuals might result in a fair analysis which might come as a distinct shock to so many people in the lighting industry who have shut their eyes and minds to what is going on in so many school systems in this country.—ROBERT T. CUTLER, *Cutler Light Mfg. Co., Philadelphia, Pa.*

Abstracts of the I.E.S. 1953 Conference papers will be featured in the September issue of I.E.

• • •

I have received my copy of the June issue of ILLUMINATING ENGINEERING. It is one of the best issues in my experience in the society. I wish to have three (3) additional copies to present to clients who are school administrators. Please send them in the near f ture if they are available and bill me.—ROBERT E. MCNEILL, *McNeill & Baldwin, Baltimore, Md.*

Ventilated vs Unventilated Luminaires

This is in regard to the paper by Mr. J. W. Steiner which appears on page 184 of the April issue of ILLUMINATING ENGINEERING. In this country we have used the Convector principle to a limited extent; but it is of much more recent introduction than the use of Dustproof Fittings equipped with glass covers which have been very extensively used in industry for over 25 years.

We look upon the Dustproof Fitting as the right answer in that it gives successful results over long periods and practically all conditions.

On the other hand, the job which depends upon convection is most successful where the lighting is in continuous 24-hour use and shows up its feature mostly where there is an upward surge of hot air from the plant. Whether the Convector type Fitting will show an advantage on the unventilated open Reflector depends very much on local conditions of each case and that is why a Dustproof equipment is more favoured.

Extended tests, such as those indicated in this paper, have been carried out in this country; but results have not been very helpful. It is intended to continue the investigations in an endeavour to get a direct comparison between the value of open Ventilated Fittings, Convector Fittings and Dustproof Fittings.

Notwithstanding the difficulty of producing useful data from specific tests, the lengthy, experience in practice has shown the value of Dustproof equipment.—HOWARD LONG, *115, Hampton Lar Solihull, Birmingham, England.*

BOOKS AND PAMPHLETS

Protective Display Lighting of Historical Documents, National Bureau of Standards Circular 538, is an 8-page booklet which covers the lighting for the display of the Declaration of Independence and the Constitution of the United States. Many of the considerations entering into the solution of this problem are applicable to the display of other documents and art treasures in general. The Bureau was requested by the Library of Congress to recommend the best means of exhibiting these documents, which should not in any way affect their preservation for indefinite time. N.B.S. Circular 538 is available from the Government Printing Office, Washington 25, D. C., at 15 cents per copy.

National Directory of Safety Films, 1953-1954 Edition, is a comprehensive listing of 963 motion pictures and slide films, both sound and silent, for safety education within business and industry, in homes, and on the streets and highways. Thoroughly indexed by subject and title, the booklet lists sources and conditions of availability, running time, and brief descriptions of each film. This directory is available from the National Safety Council, National Directory of Safety Films, 425 North Michigan Ave., Chicago 11, Ill. Price, 75 cents for one to ten copies; quantity prices listed.

Some Whys and Hows of Modern School Lighting, a new booklet reviewing recent trends in school lighting theory and practice, has been published by Sylvania Electric Products Inc. Written in non-technical language by Willard Allphin, school lighting authority, it is illustrated with photographs and charts. Among the topics discussed are quantity and quality of light and brightness contrast; comparative costs of incandescent and fluorescent lighting; and various types of lighting systems. Recommended lighting levels in classrooms, auditoriums, and halls are reviewed as are the results of studies on the correlation between light levels and speed of learning. The author approaches the problems of adequate school lighting both from the standpoint of new school buildings and of the modernization of lighting systems in older buildings. The booklet may be obtained on request from Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

Planned Street Lighting Program, booklet B-5800, is a 27-page pamphlet giving information necessary for such a program, in six steps: determining present conditions, classifying streets, establishing lighting needs, order of preference, selection of equipment, and making the layout. Copies of booklet B-5800 are available from Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

The 1953 edition of the **Heating, Ventilating, Air Conditioning Guide,** which is published annually by A.S.H.V.E., is now available from the American Society of Heating and Ventilating Engineers, 62 Worth St., New York 13, N. Y. This 31st edition contains 51 chapters (1096 pages) illustrated with charts and tables in the Technical Data Section; and also contains a catalog data section (463 pages). This completely indexed Guide is said, by the publishers, to contain important revisions throughout the text. Price, $7.50.

The National Electrical Manufacturers Association has recently published the following standards, and copies are available, at prices listed, from N.E.M.A., 155 E. 44th St., New York 17, N. Y.

EEI-NEMA Standards for Distribution Transformers (Overhead Type), Publication No. 114-1953 (complete revision of Fourth Report) — Price, $1.00 per copy.

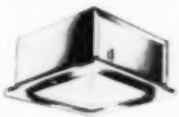
NEMA Definitions, Standards and Purchase Specifications for Marine-propulsion Steam Turbines and Gears, Publication No. MP1-1953 — Price, $3.25 per copy.

NEMA Standards for Land Gas Turbine Power Plants, Publication No. TU6-1953 — Price, $1.00 per copy.

NEMA Standards for Metallic Rectifiers, Publication No. MR1-1953—Price, $3.50 per copy.

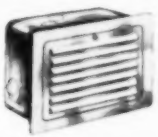
(New Member Listing on page 34A)

DERBY DOWNLIGHTS—Endless applications. 7″ diameter recessing downlights, available with matt black removable louver or with Holophane Controlens*. UL approved.



DUO-FRAME UNITS—Recessing units with Holophane, Corning, and Phoenix glassware. Two-piece frame. Drop hinges. Vertical and horizontal lamp mounting units. UL approved.

EXIT SIGNS—Surface, recessing, top and end mounting units. Metal stencil sign faces, backed by red glass. HOT-BONDED lustre aluminum finish. UL approved.

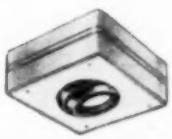


NITE LITE—One-piece, die-drawn recessing box. Louvered face with concealed hinge for easy servicing. Stainless steel or baked lustre aluminum finish. UL approved.

BED LAMP—Direct-indirect hospital unit. For three 50/60 watt lamps. Stainless steel finish. Controlens* panel in bottom, diffusing glass in top. UL approved.

PLEXOLINE® ACCENT UNITS—For use singly or with PLEXOLINE linear units. Adjustable and fixed units. Louvered body provides spill light on sides. UL approved.

TROFFER ACCENT UNITS—Self-contained square recessing units, adjustable or fixed, flange or snap-in type. May be used singly, within or at end of troffer runs. UL approved.



SURFACE MOUNTED ACCENT UNITS—Adjustable units or fixed units with Holophane Controlens*. May be used singly or with VIZ-AID® or LENOX® fixtures. UL approved.

RECESSING CORRIDOR UNITS—Available with two optical characteristics: asymmetric and symmetric. Flange or snap-in. Holophane* prismatic glass globe. UL approved.

*® HOLOPHANE CO., INC.

A complete line of incandescent units by Day-Brite

When the name "Day-Brite" is mentioned, you think of the nation's finest line of fluorescent fixtures. This is to remind you that there's an equally fine line of Day-Brite incandescent units—giving you the advantages of Day-Brite quality and design for every piece of equipment called for in any type of lighting job. Write for full descriptive product information on the Day-Brite incandescent line. You'll find it a valuable addition to your files.

"DECIDEDLY BETTER"
DAY-BRITE
Lighting Fixtures

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Over 8000 in use ...and still going

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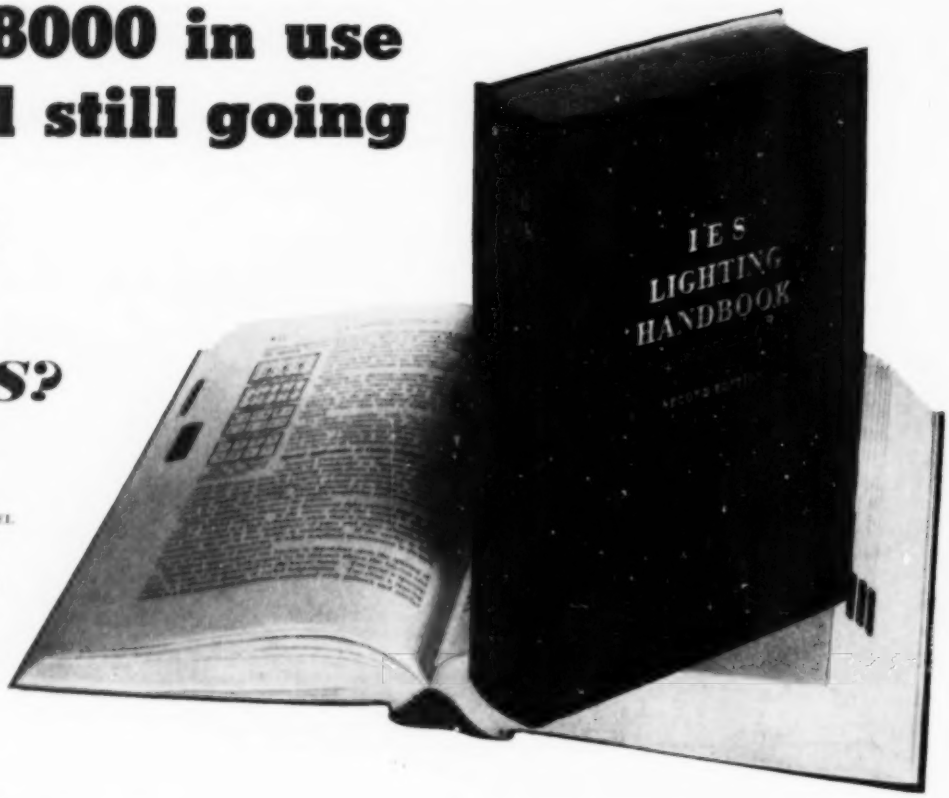

Who Needs the I.E.S. Lighting Handbook

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ELECTRICAL CONTRACTORS
PLANT MAINTENANCE MEN
CONSULTING ENGINEERS
MANUFACTURERS
OPTOMETRISTS
ARCHITECTS
ALL WHO NEED LIGHTING INFORMATION

Price $8.00* per copy

Yes, since January 1952 over 8000 copies of the Second Edition, I.E.S. Lighting Handbook have been sent out in industry . . . to every type of lighting person . . . and in every quarter of the globe from Succasunna, N. J. to Singapore. Small wonder we're now preparing for the second printing of this wonderful reference work for anyone interested in good lighting practice.

Not only does the Handbook show you "how" to do it. It also tells "why" . . . gives you sound background for applying the hundreds of advanced lighting techniques shown in its 987 pages. Illustrates every step of the way with 655 large, clear photographs, charts and curves, and is fully cross-indexed for quick, easy reference. No "light reading" (or pun intended), the Second Edition, I.E.S. Lighting Handbook has been praised by scholars and laymen as the last word in practical lighting information.

If your lighting library is still incomplete (that is, of course, without the *latest* I.E.S. Lighting Handbook), now is the time to place your order for your new Handbook. Preparation and printing delays for a second printing are always unpredictable.

Get your copy now and be sure! Only $8 per copy.

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New G-E Rapid Start lamp needs no starter, cuts maintenance

IN THE NEW RAPID START lamp circuit G-E has been able to eliminate the starter required in standard lamps to pre-heat the cathode. For that reason, maintenance is even easier, more economical than before.

This new General Electric *Rapid Start* lamp was made possible by two G-E developments: an improved triple-coil cathode that replaces the double coil in standard fluorescent lamps, and a *Rapid Start* ballast. Together, they give General Electric *Rapid Start* lamps almost instant starting and smooth, simple operation.

G-E *Rapid Start* fluorescent lamps are rapidly becoming available. Many leading fluorescent lighting fixture manufacturers are incorporating the new lamps and ballasts in their latest equipment. These two newest developments of G-E research are another reason why you can *expect* the best value from General Electric fluorescent lamps.

You can put your confidence in—

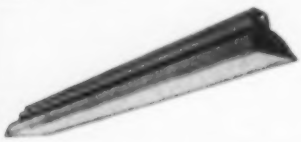
GENERAL ELECTRIC

lighting problems SOLVED for every plant location with a specific Benjamin Unit

☑ THIS CHECK CHART OF BENJAMIN LIGHTING UNITS

shows how lighting can be matched to every seeing task in the plant!

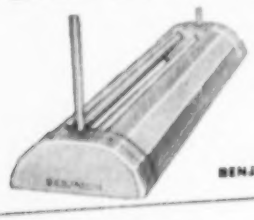
☐ **1.** fluorescent lighting of **GENERAL PLANT AREAS**



Over 300 combinations for matched-to-the-task lighting. Just three channel sizes and four types of reflectors form the backbone of an almost unlimited number of lighting systems for general industrial seeing tasks. Features utilization of high-light-output T12 Slimline lamps and exclusive "Springlox" Lampholders for lower maintenance cost through quicker lamp servicing.

BENJAMIN "Magna-Flo" Systems *described in Manual #1*

☐ **2.** fluorescent lighting to overcome **EXCESSIVE BRIGHTNESS RATIOS**



A new high in seeing comfort for industry! "Task-Master" combines greater upward flow of light with a new high of 35° lamp shielding. Revolutionary new, easier methods of installation and maintenance keep operating and maintenance costs at an all-time low.

BENJAMIN "Task-Master" *described in Manual #2*

☐ **3.** lighting of **HIGH BAYS**

A rugged lighting unit for steel mills, foundries, sheet metal works, and other locations where the lighting units must be guarded against damage from rough handling, flying metal particles, severe mechanical strain or unfavorable atmospheric conditions.

BENJAMIN "Steelite" *described in Manual #3*

☐ **4.** incandescent lighting of **GENERAL PLANT AREAS**

This unit inexpensively matches a variety of general seeing tasks; also for stairways, materials handling areas, etc. Exclusive "Turnlox" detachable reflector cuts time required for cleaning and relamping.

BENJAMIN "Turnlox" Dome Reflector *described in Manual #4*

☐ **5.** lighting for **BINS and SHELVES**

A reflector of unique design, combining uniformity of illumination with careful shielding. Uniformly lights top-to-bottom of shelves, bin tiers in stock rooms, tool cribs and book stacks. Especially adapted for the low mounting heights and narrow aisles of such locations.

BENJAMIN "Stock-Bin-Lite" Reflector *described in Manual #5*

☐ **6.** safe lighting for **HAZARDOUS LOCATIONS**

For locations listed by U.L. as Class 1 Groups C and D. Recommended for areas where explosive atmospheres or inflammable dust is found. Available in a choice of four reflectors and a variety of mountings. Especially constructed to withstand the tremendous pressure of internal lamp explosion.

BENJAMIN "Explosion-Proof" Units *described in Manual #6*

☐ **7.** approved lighting for **HUMID LOCATIONS**

Listed "Vapor-Tight" by U.L. Suitable for use in locations exposed to moisture or non-combustible dust, corrosive fumes, vapors, dust and smoke. Rugged construction, unbroken surface of Porcelain Enamel and heavy-gauge steel assure long life without breakdown or frequent servicing.

BENJAMIN "Vapor-Tight" Units *described in Manual #7*

☐ **8.** proper floodlighting for **OUTDOOR INDUSTRIAL AREAS**

The ideal all-weather unit for industrial recreational areas, ball fields, pools, etc. Highest quality outdoor illumination due to combination of large diffusing Porcelain-Enameled Steel Reflector with inner aluminum reflector.

BENJAMIN "Play Area" Floodlight *described in Manual #8*

☑ GET THESE FREE LIGHTING MANUALS!

- ☐ 1. General Plant Lighting (fluorescent)
- ☐ 2. Controlled Brightness for greater seeing comfort
- ☐ 3. High Bay Lighting
- ☐ 4. General Plant Lighting (incandescent)
- ☐ 5. Stock-Bin Lighting
- ☐ 6. Hazardous Locations
- ☐ 7. Humid Locations
- ☐ 8. Industrial Floodlighting

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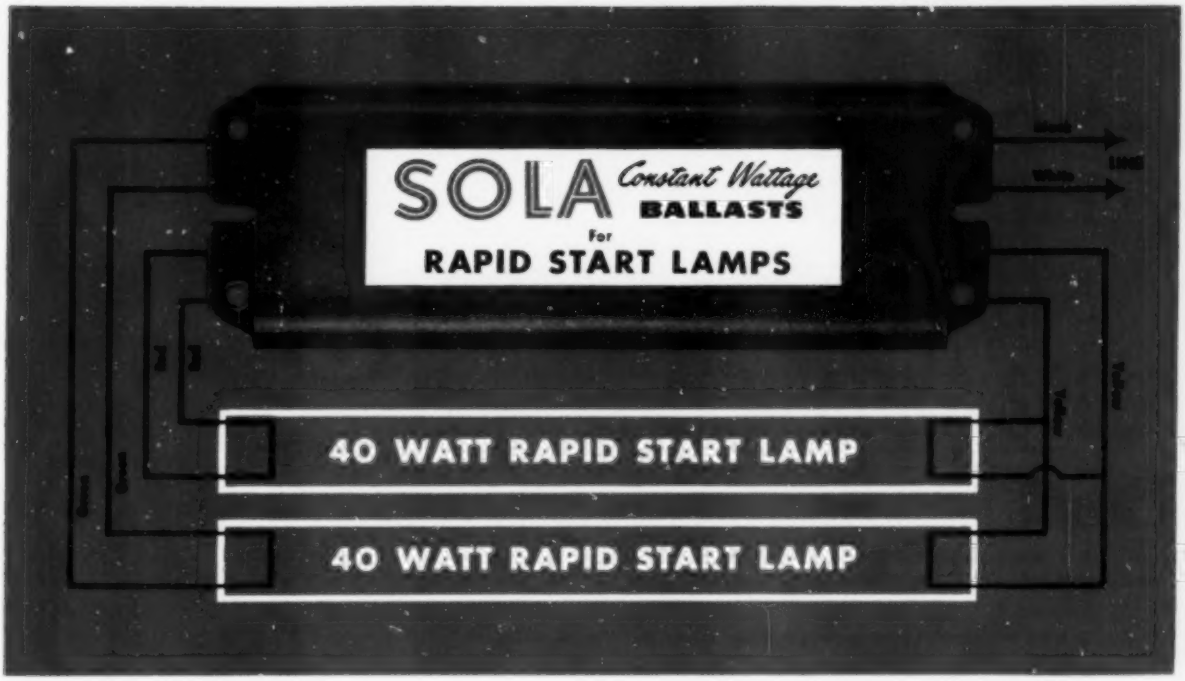

Here is *the lighting system* that automatically, unfailingly

maintains the performance you specify

The rapid start lamp and the Sola Constant Wattage Ballast together form the heart of an entirely new fluorescent lighting system. All the inherent advantages of the rapid start lamp are enhanced when operated from a Sola Constant Wattage Ballast regardless of line voltage conditions. This is the finest ballast that Sola Electric Co. engineers have ever created, and they have introduced a notable number of ballast "firsts." Here is a unique lighting system resulting in performance that is unsurpassed from any point of view. Check the list below. Compare and you will specify Sola Constant Wattage Ballasts for your rapid start lamp installations.

USERS:

Accelerated life tests indicate exceptionally long lamp life relatively unaffected by the number of starts . . . radio interference suppressed . . . completely safe during lamp changes . . . unusually quiet . . . positive light upon closing switch.

ARCHITECTS:

Constant light output within ±2.5%, with line voltage variations as great as ±10% . . . cooler operation (average heat rise 50°C) for reduced air conditioning load . . . UL listed . . . meets proposed Certified Ballast Manufacturer's specifications and every suggested requirement of major lamp manufacturers.

FIXTURE MANUFACTURERS:

Lower initial costs compared with instant start . . . simplified wiring . . . permits use of conventional bi-pin lamp holders with absolute safety since the circuit of the ballast is self protecting against shock hazard . . . series type circuit which has been recommended for rapid start lamps by major lamp manufacturers.

CONTRACTORS:

Only two wires, directly from the ballast, to connect on the line, no wiring to lamp sockets . . . ballast has extremely long life since it is very cool in operation . . . self protecting under abnormal conditions, when lamp failure occurs the ballast actually runs cooler, not hotter . . . gives your customer *all* the light he pays for because of constant wattage feature.

SOLA *Fluorescent* BALLASTS

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Papers

Save time . . . bother

Important to registrants and all members of I.E.S. are the preprints of the technical papers to be presented at the coming National Technical Conference . . . printed and ready for the opening sessions. These papers present all that is new in theory and techniques of lighting and are an invaluable reference source. Even if you can't attend the Conference, the preprints will give you a detailed panoramic view of new developments in the lighting field. Papers are assembled in sets of 30 and will be available at the Conference Registration Desk when you "check in," for reference use at the sessions and in the future.

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NEW MEMBERS

At the meeting of the I.E.S. Council Executive Committee, held in New York, N. Y. on July 1, the following were elected to membership:

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Member:
Reilly, W. P., Arizona Public Service Co., Phoenix, Ariz.
Associate Members:
Alber, A. E., Arizona Public Service Co., Chandler, Ariz.
Heubeck, R. L., Yavapai Electric Co., Prescott, Ariz.
Human, J. P., Arizona Public Service Co., Casa Grande, Ariz.

CAROLINAS SECTION

Associate Member:
Leonard, J. O., Jr., Westinghouse Electric Supply Co., Greensboro, N. C.

CENTRAL ILLINOIS CHAPTER

Associate Members:
Blase, A. J., Beling Engineering Consultants, Peoria, Ill.
Wynant, J. P., Wynant Electric, Pontiac, Ill.

CENTRAL NEW YORK SECTION

Member:
Moyer, E. L., Malcolm B. & Edwin L. Moyer, Syracuse, N. Y.
Associate Member:
Hofstetter, Murray, 53 Genesee St., Auburn, N. Y.

CHICAGO SECTION

Associate Members:
Byrnes, Roger, All-Bright Electric Products Co., Chicago, Ill.
Closs, G. N., Gallagher-O'Brien Electric Co. Inc., Chicago, Ill.
Herdrich, D. J., Efengee Electrical Supply Co., Chicago, Ill.
Johnson, Miss Sis, Efengee Electric Supply Co., Chicago, Ill.
Orelove, A. E., Grayco Products, Chicago, Ill.

CONNECTICUT SECTION

Member:
Braunstein, Alfred, 159 State St., New London, Conn.

CORNHUSKER CHAPTER

Associate Member:
Cramer, W. A., Westinghouse Electric Corp., Sioux City, Ia.

FLORIDA CHAPTER

Associate Members:
Bryant, W. J., Raybro Electric Supplies Inc., Orlando, Fla.
Smith, B. T., International Business Machines, Orlando, Fla.

FOREIGN NON-SECTION

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Hecht, C. T., Philips Colombiana S. A., Bogota, Colombia.
Mooney, Mrs. E. S., The Jardine Engineering Corp. Ltd., Hong Kong, China.
Associate Members:
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Sanada, Y., Chugoko Electric Power, Hiroshima, Japan.

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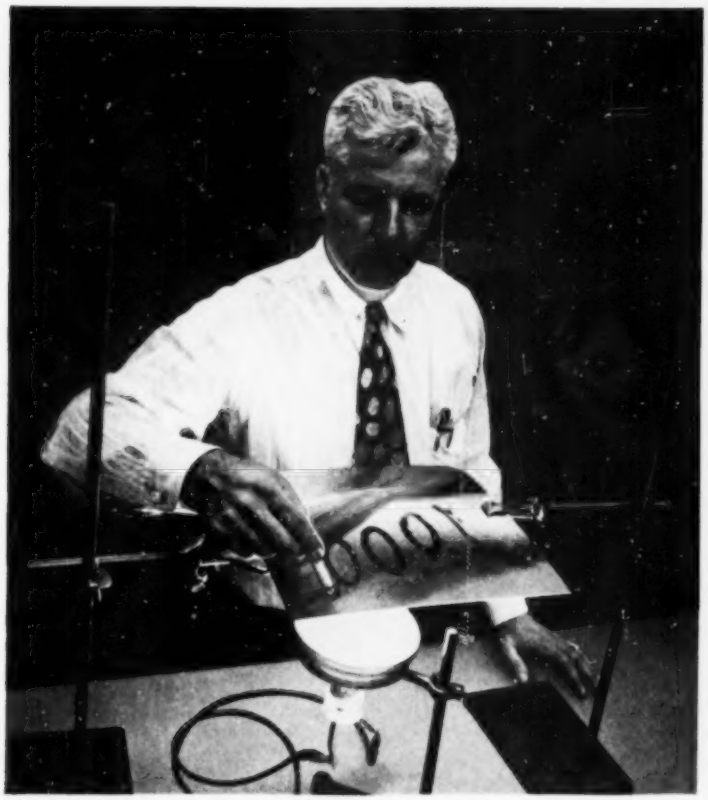
Chellew, E. M., 5114 Graceland Ave., Indianapolis, Ind.
Rowe, R. F., General Electric Co., Ft. Wayne, Ind.

(Continued on page 36A)



IN JUST 5 SECONDS, the markings from a temperature-indicating crayon, rated at 1,000°F., melts to liquid on a metal sheet placed a few inches over the Sylvania Instant Heat Cooking Unit.

NEW SYLVANIA UNIT BRINGS

HIGHER HEATING SPEED

TO ELECTRIC RANGES

ANOTHER SYLVANIA DEVELOPMENT IN THE ADVANCE TOWARD BROADER APPLICATIONS OF ELECTRIC LIGHT AND POWER.

After several years of exhaustive research, Sylvania Engineers have developed a new and amazingly fast-operating top heating unit for electric ranges.

Essentially, this is an infrared lamp of 1550 watts mounted in a metal reflector, and covered with a red, heat-resistant glass top. The inside of this lamp is *GOLD-COATED* because gold coating gives the highest heat reflection.

Instead of gradually conducting heat to a cooking pot or pan, this unit instantly *radiates* heat at full blast. And, because there are no thick wire coils or metal tubing to absorb the heat, you get desired high temperatures at the flick of a switch.

With this unit, bacon fries in 30 seconds. Fried eggs are cooked in 2 minutes; frozen vegetables are steaming hot in 3 minutes.

Heat you can see!

No guess work whether or not this new unit is turned *on*. The infrared lamp immediately signals "hot" with a cheerful red glow.

And for details about this 1550 watt infrared lamp's use in industrial applications, write to: Sylvania Electric Products Inc., Dept. 3L-3008, 1740 Broadway, New York 19, N. Y.

QUICK HEATING of Sylvania's new Instant Heat Cooking Unit is shown by this laboratory test during which a sheet of heavy paper, held above the unit, became charred in just 30 seconds after the lamp was turned on.

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LIGHTING • RADIO • ELECTRONICS • TELEVISION

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ABOLITE OUTLET BOX REFLECTORS

Fits any standard 4" junction box. Built-in porcelain receptacle makes wiring simple. Reflector top doubles as cover. Screw driver is the only tool needed to install. See the ABOLITE outlet box reflector at your wholesaler. Two shapes—RLM type and shallow dome.

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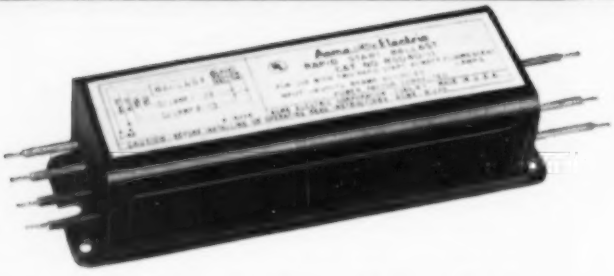

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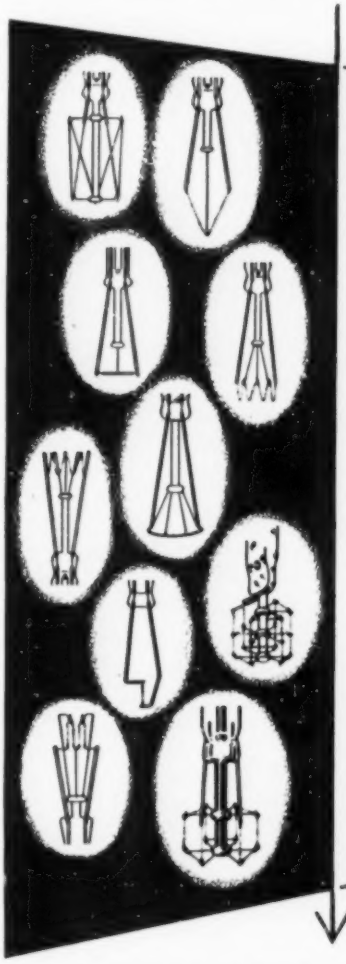
Filamentary facts about *Champion Lamps*



FACTS OF LIGHT

For a 60 watt filament you start with a straight piece of tungsten wire 21 inches long, drawn to a diameter equal to just 2/3rds the thickness of this page. When this wire has been coiled 1200 times around a molybdenum mandrel, drawn with a tolerance 1/30th the thickness of this page, its length becomes 3.4 inches. For higher concentration of heat and, hence, more light, the coil is coiled again to a double coil only 5/8ths inch in length.

After the molybdenum mandrel has been dissolved by acid, the length and uniformity of each pure tungsten coil must pass relentless inspection. Microscopic variations can seriously impair lamp life. Weight is tested on equipment that can weigh a pencil mark.

Working with wire so fine as to be almost invisible, to tolerances measured in millionths, Champion experts produce filaments that cannot be surpassed in performance. Starting at the very beginning of the lamp industry, Champion has taken advantage of every scientific advancement and quality control technique to produce Lamps for industry that provide unsurpassed service and value.

•

Pictured are a few basic filament arrangements for Champion Incandescent Lamps, each designed for specific service needs.

There is a distributor of Champion Incandescent and Fluorescent lamps near you. Do get in touch with him for intelligent and efficient cooperation on your lighting needs.

Let us mail you a new booklet L, CHAMPION QUALITY, containing the complete interesting story of Champion Lamps for industry.

CHAMPION SINCE 1900

CHAMPION LAMP WORKS
Lynn, Massachusetts
A DIVISION OF CONSOLIDATED ELECTRIC LAMP CO

the PFAFF & KENDALL story in Levittown, Pa.

Levittown, Pa. is a very *special* town in many ways! It is completely pre-planned for 16,000 homes to be ready in December 1954 . . . together with churches, schools, shopping centers and playgrounds so vital to the residents of what will be Pennsylvania's 10th largest city!

Street lighting will be really something to see . . . *and see by!* Underground wiring . . . anti-glare reflectors . . . photo-electric cell relays to turn lights on and off with sunset and sunrise . . . *and more than 3,000 PFAFF & KENDALL All-Aluminum Standards and Brackets* to carry more than 650,000 candlepower of light! Arterial highways will get similar lighting treatment.

FOUR GOOD REASONS WHY P & K ALL-ALUMINUM STANDARDS AND BRACKETS WERE SELECTED:

- *Much lighter weight* for low installation cost
- *Negligible corrosion* for longest life
- *No painting required* means large, long time savings
- *Knockdowns, if any, easily salvaged and re-used*

Write for Latest P & K Catalog . . . and Use the P & K Planning and Advisory Services without Obligation.

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20 ft. pedestal type standard with special P & K tapered lighting arm used for the first time. At Levittown, Pa.

SEE FOR YOURSELF WHAT MODERN LIGHTING MEANS

STATE DIV. OF ARCHITECTURE, LOS ANGELES

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There are many reasons why Sunbeam's shallow, plastic shielded #P1290 series luminaires are being specified all over the country in offices, schools and commercial interiors. The simple lines and refined design makes the fixtures harmonize with modern architectural motifs. High efficiency, exceptional low brightness and pleasant lighting quality are technical reasons for their demand. After seeing an installation of Sunbeam's #P1290 units, we are confident you will agree it is fluorescent lighting at its best.

SUNBEAM LIGHTING CO., 777 E. 14th Place, Los Angeles, California

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DESIGN: *Functional—clean, simple lines.*

EASY *2-way lamping—1 ladder position.*

STRENGTH: *Rigid 1-piece steel louver.*

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Where the installation calls for exceptional commercial lighting

there is nothing finer than **MITCHELL module**
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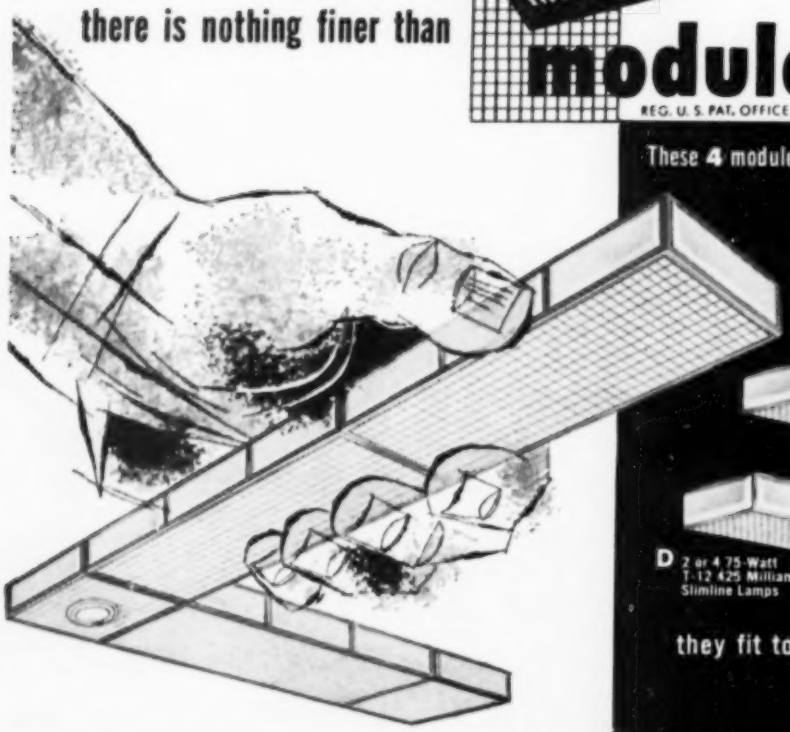
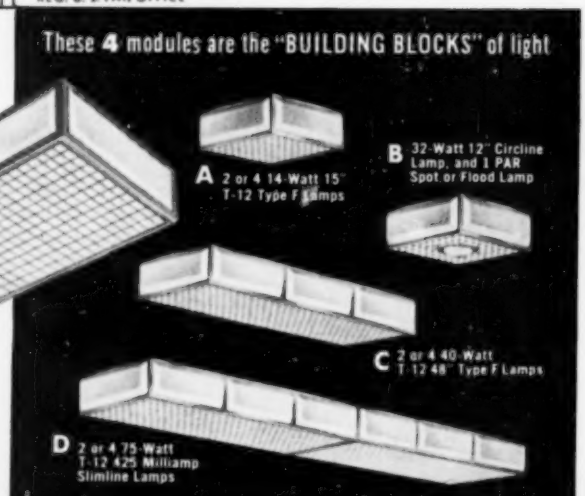


These **4** modules are the "BUILDING BLOCKS" of light


A 2 or 4 14-Watt 15" T-12 Type F Lamps
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they fit together like this

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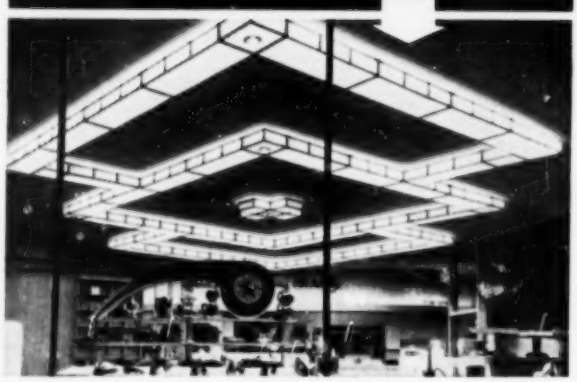

custom-fits *any commercial interior—at no more than the cost of ordinary fixtures*

50,000 DIFFERENT PATTERNS POSSIBLE
20% MORE LIGHT

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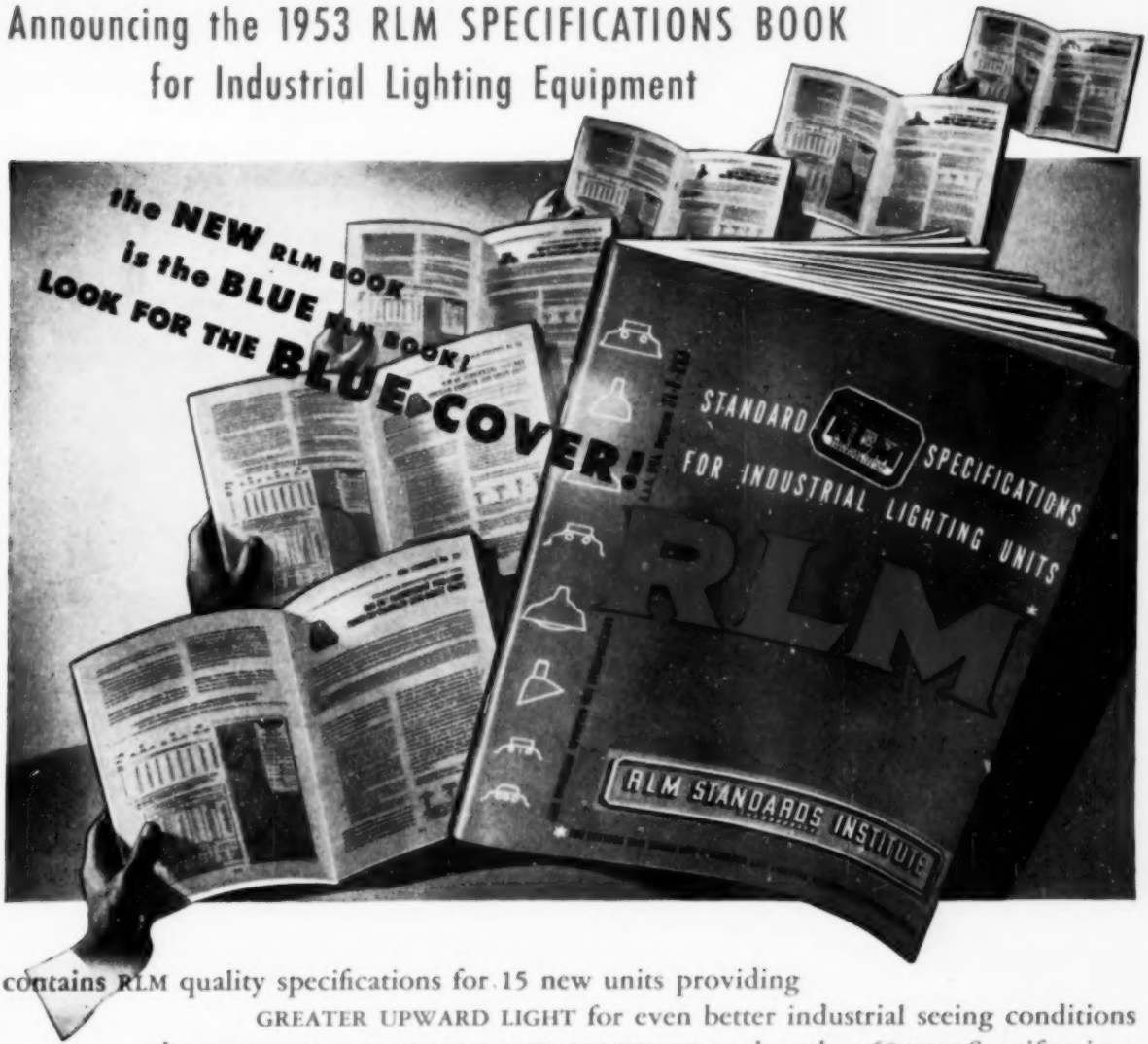
Announcing the 1953 RLM SPECIFICATIONS BOOK for Industrial Lighting Equipment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contains RLM quality specifications for 15 new units providing
GREATER UPWARD LIGHT for even better industrial seeing conditions
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OPEN LIKE A LATTICE
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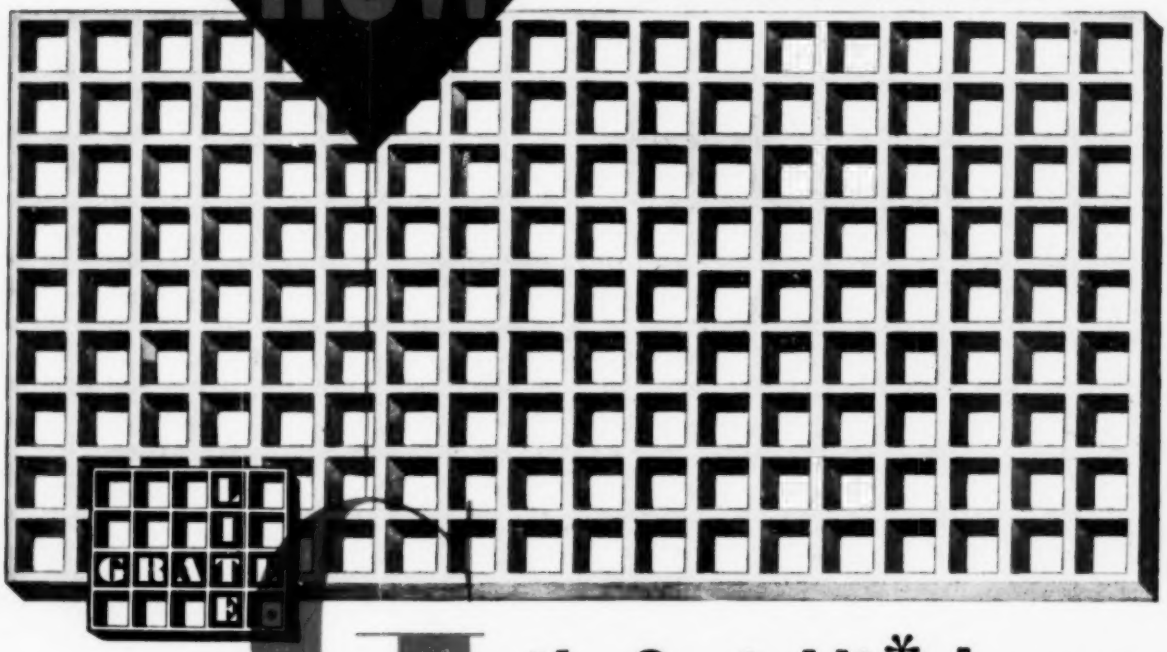

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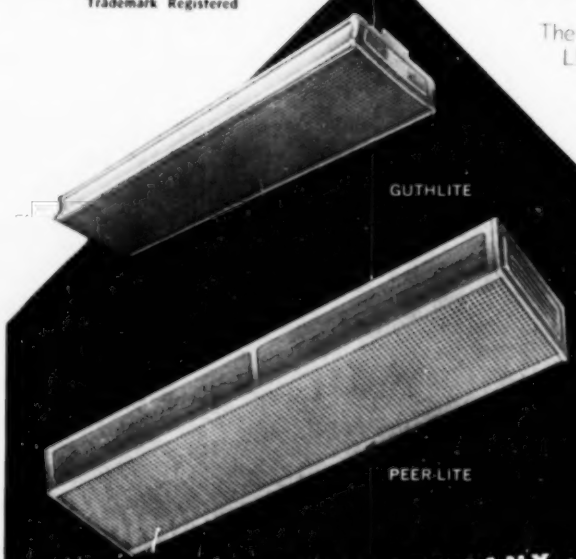

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